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NEW RECORDS AND DESCRIPTIONS OF TRYPANORHYNCH CESTODES FROM AUSTRALIAN FISHES

I. BEVERIDGE & R. A. CAMPBELL

Summary

Collections of trypanorhynch cestodes in the South Australian Museum, the Queensland Museum and the Australian Museum were examined. New host or geographical records as well as new morphological details are provided for the following species : Tentaculariidae : *Tentacularia coryphaenae* Bosc, 1797, *Nybelina thyrsites* Korotaeva, 1971, *Nybelina sphyrnae* Yamaguti, 1952; Hepatoxylidae: *Hepatoxylon trichiuri* (Holten, 1802), *Hepatoxylon megacephalum* (Rudolphi, 1819); Sphyricephalidae: *Sphyricephalus tergestinus* Pinter, 1913; Otobothriidae: *Poecilancistrum caryophyllum* (Diesing, 1850); Lacistorhynchidae: *Callitetrarhynchus gracilis* (Rudolphi, 1819). *N. sphyrnae*, *H. megacephalum* and *S. tergestinus* are reported from Australia for the first time. The adult of *N. thyrsites* is described for the first time.

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Collections of trypanorhynch cestodes in the South Australian Museum, the Queensland Museum and the Australian Museum were examined. New host or geographical records as well as new morphological details are provided for the following species: Tentaculariidae: *Tentacularia coryphaenae* Bosc, 1797, *Nybelinia thyrsites* Korotaeva, 1971, *Nybelina sphyrnae* Yamaguti, 1952; Hepatoxylidae: *Hepatoxylon trichiuri* (Holten, 1802), *Hepatoxylon megacephalum* (Rudolphi, 1819); Sphyricephalidae: *Sphyricephalus tergestinus* Pinter, 1913; Otbobthriidae: *Poecilancistrum caryophyllum* (Diesing, 1850); Lacistorhynchidae: *Callitetrarhynchus gracilis* (Rudolphi, 1819). *N. sphyrnae*, *H. megacephalum* and *S. tergestinus* are reported from Australia for the first time. The adult of *N. thyrsites* is described for the first time.

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Between 1985 and 1987, a survey of the cestode parasites in elasmobranch fishes in the Australian region was undertaken. The resulting collections, following the examination of 1 294 specimens belonging to some 98 species (Beveridge 1987, 1991) are now housed in the South Australian Museum. Prominent among the collections made were trypanorhynch cestodes including a number of new genera and species and other genera new to the Australian region (for summary, see Campbell & Beveridge 1994).

The purpose of this communication is to report additional species encountered during the survey, several reported for the first time from Australia, or from collections already housed in the South Australian Museum, the Australian Museum and the Queensland Museum. A substantial collection of larval trypanorhynchs from teleost fishes has also been made available for study by various colleagues, and the collation of data on the occurrence of both adult and larval forms provides ecological insight into the life-cycles of the parasites concerned. In addition, new observations are included on the morphology of several of the cosmopolitan species encountered.

Illustrations are provided for the species discussed. Particularly with trypanorhynch cestodes, adequate illustrations provide clear evidence of the accuracy of identifications made, without reliance on textual description. Written

descriptions are provided only for species that have been poorly described or which have not been described as adults in the past.

MATERIALS AND METHODS

Adult cestodes collected by the writers were washed in sea-water or tap-water and fixed in hot 70% ethanol or hot 10% formalin. In some instances, spiral valves were opened, cestodes were killed *in situ* by flooding the gut with near boiling water and formalin was added immediately to fix the cestodes. In the laboratory, cestodes were removed from spiral valves, cleaned in water and were stored in 70% ethanol. Plerocerci were dissected free of any enclosing membranes and placed in tap-water to induce eversion of tentacles, then fixed in 70% ethanol. Cestodes were examined either as temporary mounts in glycerol or were stained in Celestine blue, dehydrated in ethanol, cleared in clove oil and mounted permanently in Canada balsam. Tentacles were removed from some specimens and mounted in glycerine jelly. The taxonomic arrangement and terminology for anatomical features and for hook patterns follows Campbell and Beveridge (1994). Synonymies of well established species are not provided, as they are available in considerable detail in Dollfus (1942).

Synonymies are provided for species which are not treated in Dollfus (1942) or which are not obtainable from other readily available sources. Measurements are presented in millimetres as the range followed by the mean in parentheses. Unless otherwise stated, mean values are based upon ten individual measurements. Where fewer than ten measurements were available, the number made is indicated by n.

The following abbreviations are used for institutions:

AHC	Australian Helminthological Collection, South Australian Museum, Adelaide
AM	Australian Museum, Sydney
BMNH	British Museum (National History), London (now The Natural History Museum)
MNHN	Muséum national d' Histoire naturelle, Paris
MPM	Meguro Parasitological Museum, Tokyo, Japan
QM	Queensland Museum, Brisbane
TINRO	Tikhookeanskogo Nauchno – issledovatel'skogo Institut Rybnogo Khozyaistva i Okeanografii (Pacific Scientific Research Institute. Fisheries, Economics and Oceanography), Vladivostok, Russia.

The personal collection from which cestodes were borrowed was that of Dr. R. J. G. Lester (RJGL). Host nomenclature follows Last and Stevens (1994) for elasmobranchs and Gomon *et al.* (1994) and Paulin (1993) for teleosts in southern Australian waters.

SYSTEMATICS

Order TRYPANORHYNCHA Diesing, 1863

Superfamily HOMEACANTHOIDEA Dollfus, 1942

Family TENTACULARIIDAE Poche, 1926

Genus *Tentacularia* Bosc, 1797

Tentacularia coryphaenae Bosc, 1797
(Figs 1–6, 54–55)

Synonymy — see Dollfus (1942)

Material examined

Adults. From *Carcharhinus melanopterus*

(Quoy & Gaimard, 1824): 3 scoleces, strobilar fragments, 'Port-Western, Australie', collected 1829, (MNHN A₂R – 1142); 3 specimens, Bundaberg, Qld. (QM GL 10806–10821). From *Carcharhinus limbatus* (Valenciennes, 1839): 1 specimen, Darwin, N.T. (AHC 24935).

Metacestodes. From *Xiphias gladius* Linnaeus, 1758: 4 specimens, Cronulla, N.S.W. (AHC S711, S2528). From *Coryphaenae hippurus* Linnaeus, 1758: 8 specimens, Barwon Banks, 20 miles NE of Mooloolaba, Qld. (AHC 18497–8). From *Macruronus novaezelandiae* (Hector, 1871): 2 specimens, west coast of Tasmania (QM G212139).

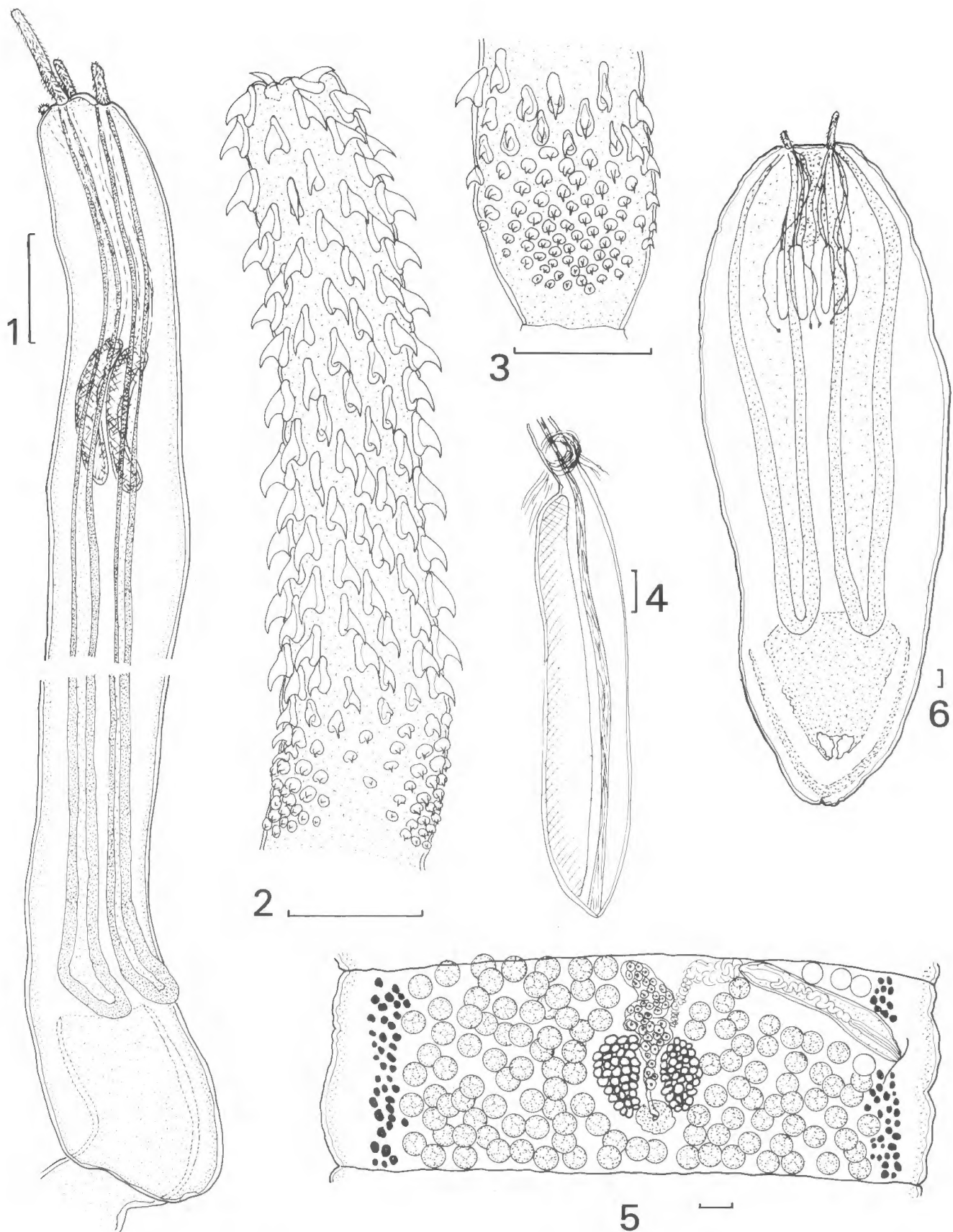
Remarks

This cosmopolitan species has been recorded only three times from Australian waters. The first record by Dollfus (1930, 1942), omitted in the checklist of Beumer *et al.* (1982), was based on specimens collected by Quoy and Gaimard in 1829 during the visit of the 'Astrolabe' to Australia under the command of Dumont D'Urville. The collection details associated with the specimen indicate that it was collected at 'Port-Western'. The 'Astrolabe' visited Westernport, Victoria, but *Carcharhinus melanopterus* is a tropical shark and does not occur in Victorian waters (Last & Stevens 1994). 'Port-Western', the locality associated with the labels, is unquestionably Westernport, Victoria as it occurs under this name in earlier maps such as Freycinet's General Chart of New Holland published in 1811 (Horner 1987 : 21). Hence, it is possible that the recorded locality is incorrect. As the voyage continued through the south-eastern Pacific, it is also possible that Quoy and Gaimard's specimens were in fact not from Australian waters, or that the host was not correctly identified.

T. coryphaenae has also been reported in *Katsuwonus pelamis* (Linnaeus, 1775) from New South Wales and Norfolk Island by Lester *et al.* (1985) and Korotaeva (1971) reported it from *Ruvettus pretiosus* Coco, 1829 (syn. *R. tidemani* Weber, 1913) from the Great Australian Bight.

The new collections confirm *C. melanopterus* as a host for the parasite in Australian waters and add the intermediate hosts *Xiphias gladius*, *Coryphaenae hippurus* and *Macruronus novaezelandiae*, all of which are new records for Australian waters.

A detailed summary of the anatomy of *T.*



FIGURES 1–6. *Tentacularia coryphaenae* Bosc, 1797. 1. Scolex. 2. Tentacle, internal surface. 3. Basal armature of tentacle, bothridial surface. 4. Tentacular bulb. 5. Mature proglottis. 6. Post larva. Figures 1–5 based on material from *Carcharhinus melanopterus* Quoy & Gaimard, 1824 (in MNHN A₂R–1142). Scale bars: Figure 1, 1.0 mm; Figures 2–6, 0.1 mm.

coryphaenae was provided by Dollfus (1942), however, several significant features of the tentacular armature, illustrated in Figs 2 and 3, warrant comment. Some members of the Homeacanthoidea were considered by Campbell and Beveridge (1994) to display bilateral symmetry in the metabasal tentacular armature, in contrast to previous authors (e.g. Dollfus 1942) who considered the symmetry to be entirely rotational. The basal armature of *T. coryphaenae*, was illustrated by Dollfus (1942), Subhapradha (1955) and Campbell and Beveridge (1994), but none of these authors have commented on the fact that *T. coryphaenae* provide an example of rotational symmetry in the metabasal armature and bilateral symmetry in the basal armature. The internal and external surfaces of the tentacle are identical, unlike the situation in the heteroacanthous trypanorhynchs (Campbell & Beveridge 1994), in which the rows form a pattern of V-s on the internal surface and A-s on the external surface. The hooks on the base of the tentacle are arranged in ascending rows similar to the pattern found in heteroacanth, while in the metabasal region, the hooks are arranged in a quincunxial pattern, typical of homeoacanth.

Genus *Nybelinia* Poche, 1926

Some 42 species have been described in the genus *Nybelinia*, many very poorly, rendering its taxonomy difficult. Dollfus (1942) described or redescribed 14 species, regarding an additional three as *inquirendae*, and subsequently (1960) added 16 new species, mainly from fish from West Africa. Four new species were described by Yamaguti (1952) from Japanese fish, three more species from fish from the Indian Ocean were added by Reimer (1980) and single species were described by Heinz and Dailey (1974) from California, by Carvajal *et al.* (1976) from Hawaii, and by Shah and Bilqees (1979), Kurshid and Bilqees (1988) and Chandra (1988) from India and Pakistan.

Separation of species is based primarily on hook size, shape and uniformity, and secondarily on the proportions of the different regions of the scolex. The genus has been divided into two subgenera, *Nybelinia* and *Syngenes*, by Dollfus (1942), based on whether the proglottides are acraspedote or craspedote. However, as the adult is not known for most of the described species, few can be assigned to subgenus. Subgenera were not considered by Campbell and Beveridge

(1994) for this reason.

Beumer *et al.* (1982) listed only one species, *N. thyrsites*, from the Australian region. Korotaeva (1971) named this species, previously known simply as '*Nybelinia sp.*' from larval stages only. The adult is described here for the first time.

Nybelinia thyrsites Korotaeva, 1971 (Figs 7–14)

Nybelinia thyrsites Korotaeva, 1971: 74–6, fig. 4.

Nybelinia thyrsites (Leiper & Atkinson, 1915) in Beumer *et al.*, 1982: 18.

Tetrarhynchus sp. of Leiper & Atkinson, 1915: 56–6, fig. 35.

Nybelinia (*Syngenes*) sp. of Dollfus, 1942: 195–7, figs 109–110.

Nybelinia (?*Syngenes*) sp. of Robinson, 1959: 146, figs 1–3.

Types

Metacestodes from abdominal cavity of *Thyrsites atun* (Euphrasen, 1791), Southern Australia in TINRO ANZ 4–35 (not examined).

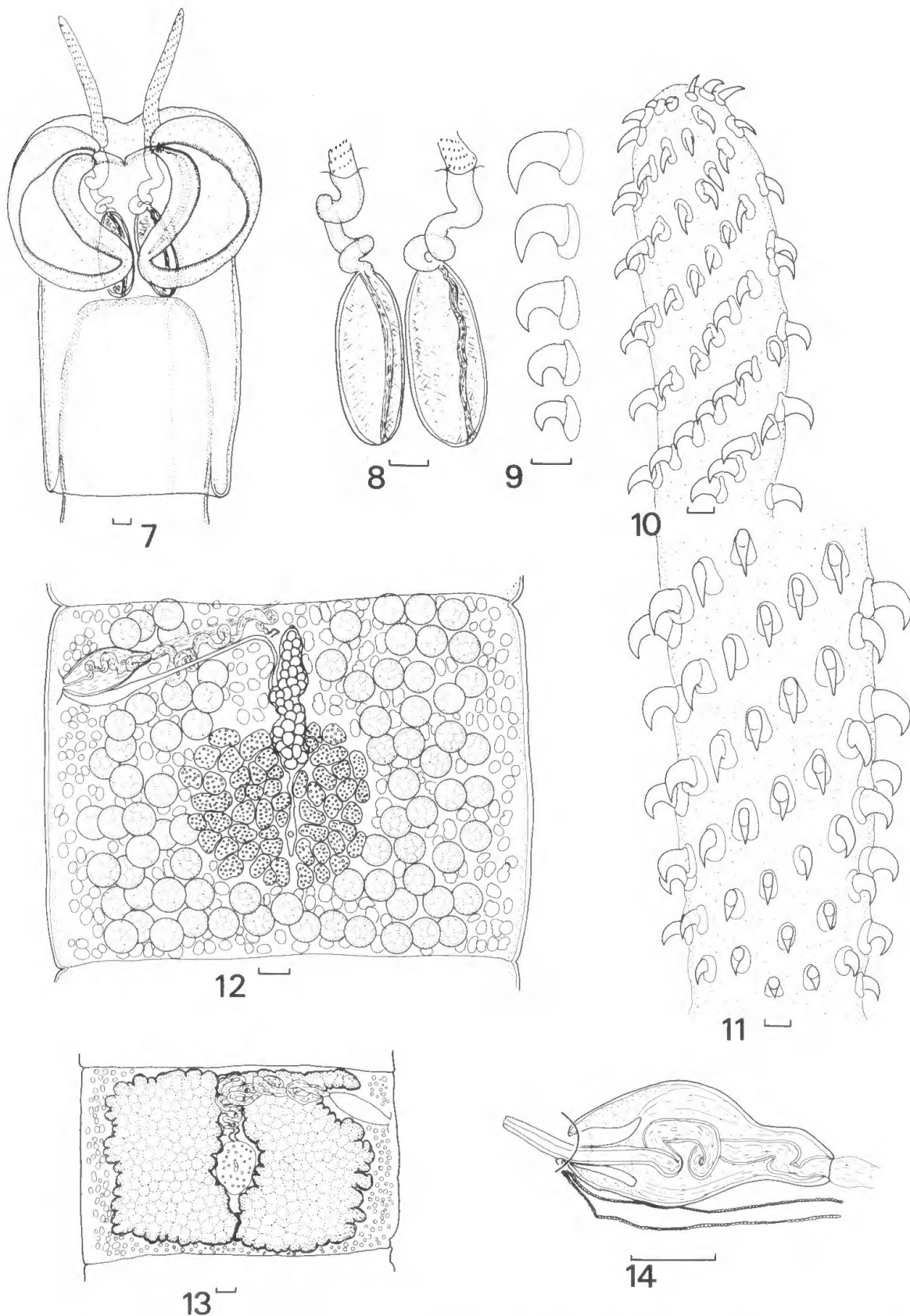
Material examined

Adults. From *Mustelus antarcticus* Guenther, 1870: 19 specimens, Goolwa, S.A. (AHC S17515–20). From *Carcharhinus brachyurus* (Guenther, 1870): 4 specimens, Goolwa, S.A. (AHC 17514). From *Galeorhinus galeus* (Linnaeus, 1758): 1 specimen, Pt Willunga, S.A. (AHC 312). From *Aptychotrema vincentiana* (Haake, 1885): 2 specimens, Goolwa, S.A. (AHC 17521).

Metacestodes. From *Arripis truttaceus* (Cuvier, 1829) (syn. *A. esper* Whitley, 1950): 2 specimens, Goolwa, S.A. (AHC 17522). From *Lepidopus caudatus* (Euphrasen, 1788): 1 specimen, Bay of Islands, New Zealand (BMNH 1914. 6.1 493–496B); 3 specimens, North Cape, New Zealand (BMNH 1914. 6.1 535–554). From unknown host: 2 specimens, locality unknown, coll. in 1829 by Quoy and Gaimard (MNH A₂R. 1140).

Description

Cestodes of moderate size, up to 173 long, 1.9 maximum width, with up to 312 proglottides in gravid specimens. Scolex craspedote, subspherical anteriorly, truncated posteriorly;



FIGURES 7–14. *Nybelinia thyrssites* Korotaeva, 1971. 7. Scolex. 8. Bulbs and sheaths. 9. Profiles of hooks along tentacle showing gradual increase in hook size. 10. Distal region of tentacle, bothridial view. 11. Basal region of tentacle, bothridial view. 12. Mature proglottis. 13. Gravid proglottis. 14. Cirrus sac and vagina. Specimens from *Mustelus antarcticus* Guenther, 1870 (AHC S17515–20). Scale bars: Figures 7, 12–14, 0.1 mm; Figures 8–11, 0.01 mm.

maximum width 0.66–1.06 (0.83) in mid-region of bothridia; 4 bothridia, approximately reniform, external margin convex, internal margins concave; internal margin thicker than external, less variable in shape; area between dorsal and ventral pairs of bothridia distinctly cordiform. Surface of bothridium covered with elongate microtriches; pars bothridialis 0.43–0.72 (0.61); pars vaginalis 0.13–0.52 (0.32), always shorter than pars bothridialis; sheaths irregularly coiled; bulb ellipsoidal, approximately three times longer than wide, 0.31–0.40 (0.37) long by 0.10–0.16 (0.13) wide. Retractor muscle of tentacle originates at base of bulb. Pars post-bulbosa 0.010–0.024 (0.017; $n=4$); bulbs end either adjacent to pars proliferans of strobila or separated from it by space; velum 0.30–0.80 (0.55) long, posterior border sometimes straight, sometimes irregular in shape.

Tentacles 0.44–0.58 (0.52) long, tapering distally; width at base (without hooks) 0.040–0.096 (0.054), width at mid-region 0.028–0.064 (0.045); width occasionally variable with narrower section in middle, which may be processing artefact. Hooks arranged in 24–27 (26; $n=8$) oblique rows, with 7–8 (7.8) hooks per half-turn; hooks uncinatate, relatively uniform in shape, with point gently curved posteriorly; hook length 0.016–0.020 (0.019), base 0.009–0.012 (0.010); hooks at base of tentacle slightly smaller, but of same shape.

Strobila acraspedote, apolytic; mature proglottides slightly wider than long 0.41–1.12 (0.76) by 0.77–1.70 (1.25). Genital pore submarginal, opening on ventral surface, in anterior third of proglottis 0.13–0.32 (0.23) from anterior margin, alternate irregularly. Cirrus sac small, ellipsoidal to subspherical, muscular wall weak, 0.18–0.35 (0.28) by 0.06–0.16 (0.12); cirrus unarmed; internal and external seminal vesicles absent; vas deferens coils anteriorly towards midline; vasa efferentia not seen. Testes 84–111 (98) in number, variable in size, 0.048–0.104 (0.071) in diameter; smallest testes near periphery of proglottis, distributed in single layer, confluent posterior to female genitalia; frequently not confluent anterior to female genitalia; rarely overlying female genitalia. Vagina narrow, straight tube, sometimes slightly dilated at distal end; vagina passes antero-medially, then turns posteriorly to descend towards ovary, terminating in diminutive seminal receptacle approximately 0.16 by 0.06. Ovary just posterior to centre of proglottis, bilobed in whole mounts, 0.30–0.60 (0.45) by 0.40–0.80 (0.56). Mehlis' gland small,

spherical, situated posterior to centre of ovary, approximately 0.24 in diameter. Vitelline follicles encircling medulla, 0.016–0.048 (0.032) in diameter. Uterine duct ascends to join uterus anterior to ovary. Uterus sacciform, in shape of inverted U anterior to ovary; arms of gravid uterus elongate, filling with eggs until dilated arms meet posteriorly; posterior part of uterine arms become filled with eggs while anterior part contains relatively few eggs, finally occupying entire medulla. Uterine pore absent. Eggs spherical, 0.024–0.040 (0.032) in diameter; unembryonated.

Remarks

The first description of this species was given by Leiper and Atkinson (1915) based on metacestodes collected from *Lepidopus caudatus* (Euphrasen, 1788) from the Bay of Islands, New Zealand, during the British Antarctic Expedition of 1912–1913. Deposited with material in the British Museum (National History) is a series of specimens from the same host species, collected at North Cape, New Zealand (BMNH 1914, 6.1, 535–54) on the same expedition but not mentioned in their publication. They named their material simply '*Tetrarhynchus* sp.' Dollfus (1942) described in some detail metacestodes from an unknown teleost collected by Quoy and Gaimard in 1829 during the voyage of the '*Astrolabe*' to Australia and the Pacific region. These specimens (MNHN A₂R. 1140) he identified as *Nybelinia* (? *Syngenes*) sp. and considered them to be identical with Leiper and Atkinson's (1915) specimens. Robinson (1959) subsequently described the same species from metacestodes collected from *Thyrsites atun* (Euphrasen, 1791), *Zeus faber* Linnaeus, 1758 and *Trachurus novaezealandiae* Richardson, 1843 from Cook Strait, New Zealand, employing the same nomenclature as Dollfus (1942). He noted that every specimen of *Thyrsites atun* examined was heavily infected, while specimens of *Lepidopus caudatus* were not infected. He suggested that Leiper and Atkinson (1915) had misidentified the host species.

Korotaeva (1971) proposed the name *N. thyrsites* for apparently the same metacestode collected from Australian waters from the abdominal cavity of *Thyrsites atun*. The types are held in TINRO and were not examined. However, the material described by Leiper and Atkinson (1915) as well as that described by Dollfus (1942) was examined and compared with a metacestode and numerous adult specimens from

South Australian waters. All were judged to be conspecific and the adult is described here for the first time. Dollfus (1942) speculated on the basis of hook morphology, that the species belonged to the sub-genus *Syngenes* which is characterised by craspedote proglottides. In fact, the proglottides of the adult are acraspedote and the species therefore belongs to the sub-genus *Nybelinia*.

The adult of this species was found commonly in the gravid state in the stomach of *Mustelus antarcticus*. In other definitive hosts, the specimens were small and immature. Two immature specimens of *N. thyrssites* were found in only one of 35 *Aptychotrema vincentiana* examined.

Beumer *et al.* (1982) cited the species as *N. thyrssites* (Leiper & Atkinson, 1915) and were probably misled by Korotaeva's (1971) use of *nom. nov.* rather than *sp. nov.* at the head of her description. She stated however that the type specimen had been deposited in the collections held in TINRO (p. 75, 'typov'e exeplyap' khranyatsya v laboratorii parazitologii morskikh zhivotni'kh TINRO preparat' no. ANZ 4-35), clearly indicating that they are the types of a new species.

N. thyrssites is characterised by homoeomorphous hooks 18–20 µm long, of comparable size on both sides of the tentacle. Species with similar morphological features are *N. strongyla* Dollfus, 1960, *N. edwinlintoni* Dollfus, 1960, *N. eureia* Dollfus, 1960, *N. palliata* (Linton, 1924), *N. anantaramanorum* Reimer, 1980 and *N. lingualis* (Cuvier, 1817). *N. strongyla*, *N. anantaramanorum* and *N. lingualis* have sharply recurved hooks whose shape differs significantly from those of *N. thyrssites*. *N. palliata* belongs to the sub-genus *Syngenes* as the strobila is craspedote, whereas *N. thyrssites* has acraspedote proglottides and belongs to the sub-genus *Nybelinia*. *N. eureia* differs from *N. thyrssites* in having longer hooks (24–25 µm), a much longer pars postbulbosa of 0.54 mm compared with a maximum of 0.024 mm in *N. thyrssites*, in having a pars bothridialis which extends to the posterior end of the bulbs and in lacking an expansive bothridial fossa.

Nybelinia sphyrrae Yamaguti, 1952
(Figs. 15–17)

Nybelinia sphyrrae Yamaguti, 1952: 56–58, figs. 83–84.

Types

Adult cestodes from *pars pylorica* of *Sphyrra zygaena* (Linnaeus, 1758), Nagasaki, Japan, in MPM (not examined).

Material examined

Adults. From *Sphyrra zygaena* (Linnaeus, 1758): 3 specimens, Goolwa, S.A. (AHC 24958).

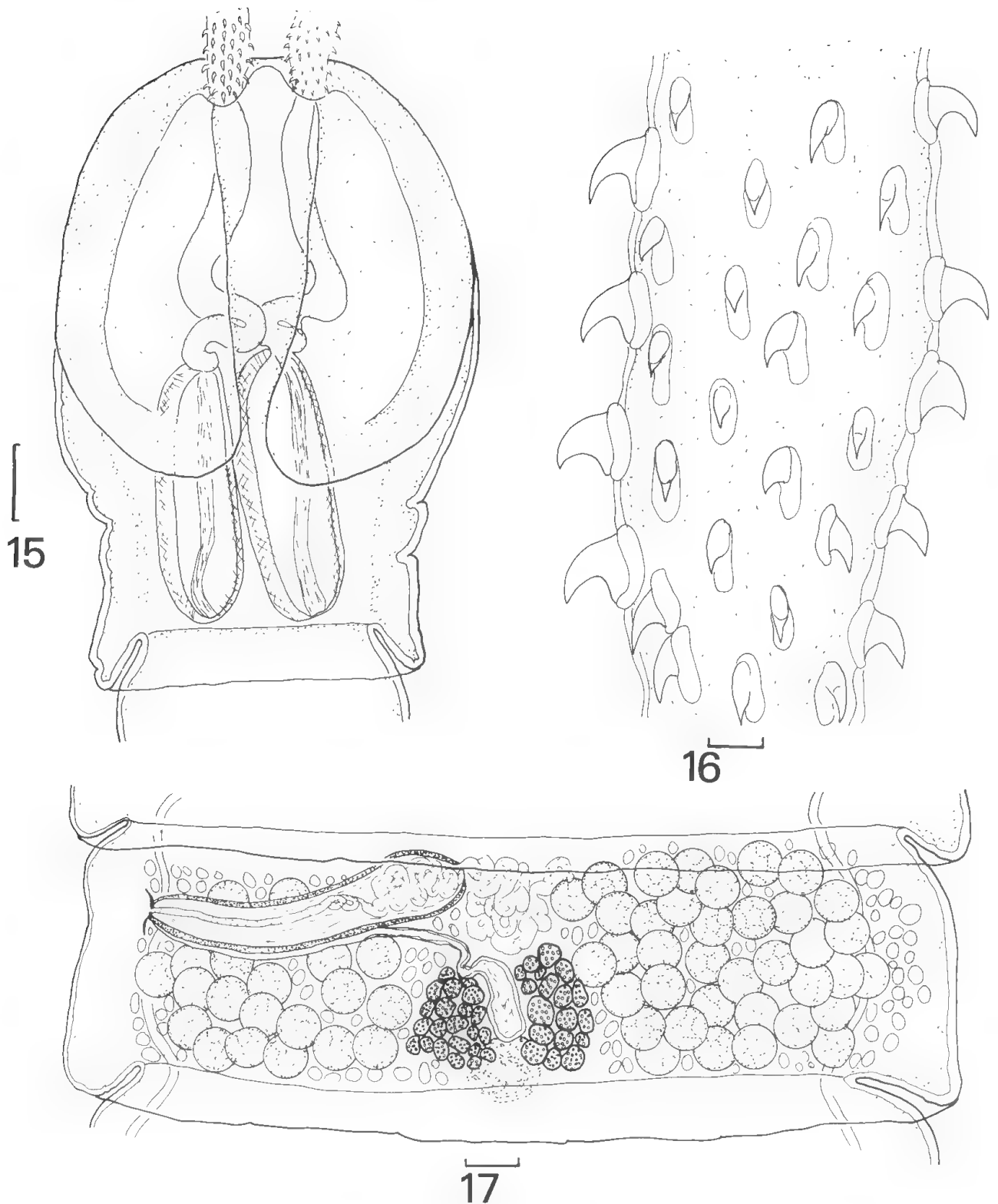
Remarks

This species is readily recognisable from Yamaguti's (1952) description, and, as indicated by the illustrations, the Australian material is clearly referable to this species. Yamaguti (1952) stated that an internal seminal vesicle was absent, however it is present in Australian specimens (Fig. 17), and Yamaguti's figure 84 shows a coiled proximal region of the cirrus which may form an internal seminal vesicle in fully mature proglottides. In addition, a small seminal receptacle was present in the Australian specimens, though not noted or illustrated by Yamaguti (1952).

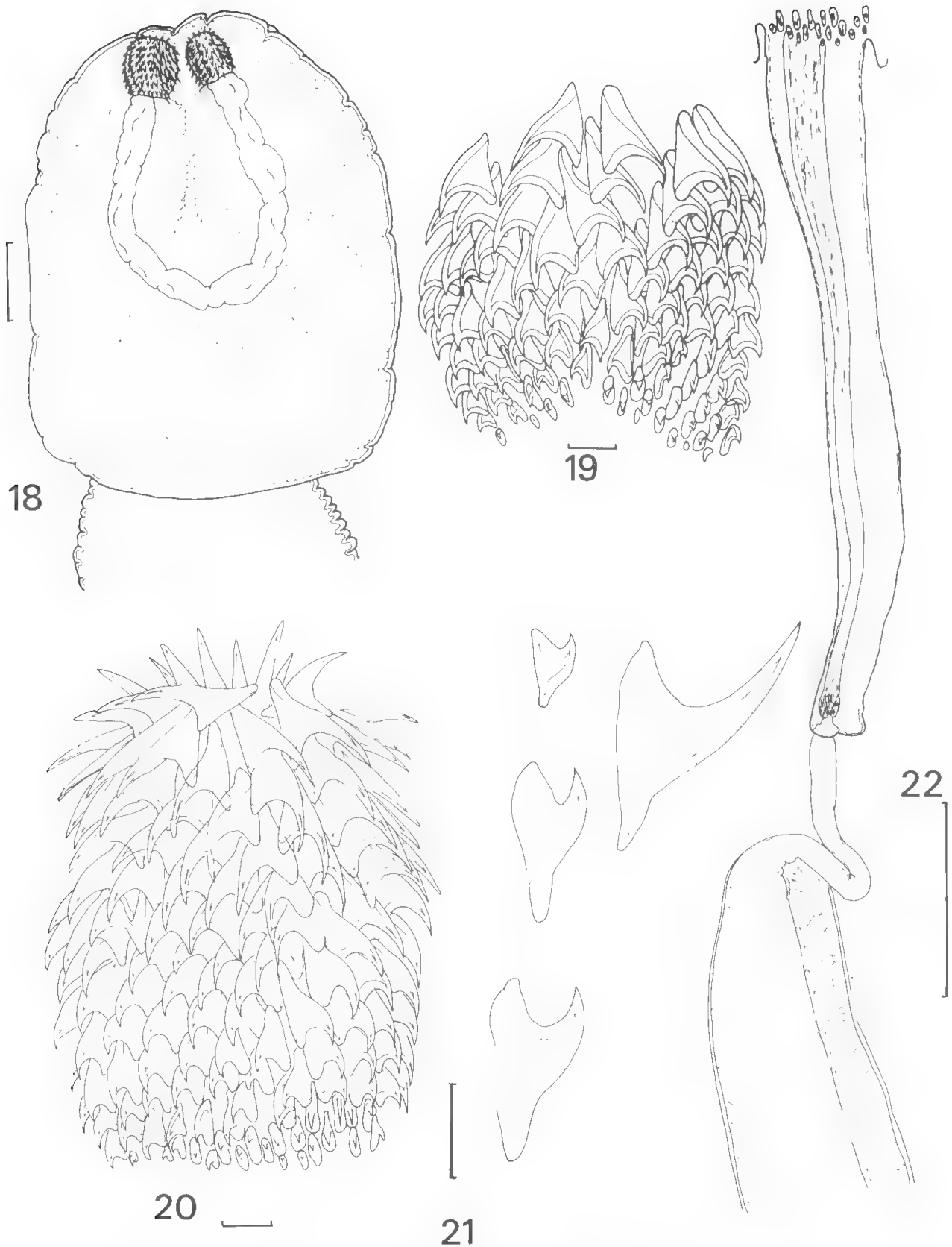
The species has not been reported subsequent to its original description (see Bates 1990), but would appear from the two records of the species to be restricted to *Sphyrra zygaena* in both northern and southern hemispheres.

N. sphyrrae differs from other species reported from hammer-head sharks, *N. edwinlintoni* Dollfus, 1960, *N. goreensis* Dollfus, 1960 from *Sphyrra lewini* (Griffith & Smith, 1834) (syn. *S. diplana* Springer, 1941) as well as *N. palliata* (Linton, 1924) and *N. syngenes* (Pinter, 1929) from *Sphyrra zygaena* in a number of features. Based on Pinter's (1929) description, it differs from *N. syngenes* in which the pars vaginalis exceeds the pars bothridialis and is differentiated from Linton's (1924) *N. palliata* in which the bothridia extend beyond the bulbs.

N. sphyrrae differs from *N. goreensis* as described by Dollfus (1960), in having smaller, more sharply recurved hooks (14–21 µm in *N. sphyrrae*, 27–30 µm in *N. goreensis*) and a shorter velum (0.08–0.13 mm in *N. sphyrrae*, 0.18–0.23 mm in *N. goreensis*). *N. sphyrrae* resembles *N. edwinlintoni* in hook size but differs in that *N. sphyrrae* has virtually no pars postbulbosa, whereas in *N. edwinlintoni* it measures 0.29 mm. In spite of these apparent differences, the available descriptions of *N. palliata* are poor, while that of *N. edwinlintoni* is based on a single larval specimen. Therefore the identification is contingent upon *N. sphyrrae* being a valid species, recognizably distinct from those closely



FIGURES 15–17. *Nybelinia sphyrnae* Yamaguti, 1952. 15. Scolex. 16. Basal armature of scolex, bothridial view. 17. Mature proglottis. Specimens from *Sphyrna zygaena* (Linnaeus, 1758) (AHC 24958). Scale bars: Figures 15, 17, 0.1 mm; Figure 16, 0.01 mm.



FIGURES 18–22. *Hepatoxylon trichiuri* (Holten, 1802). 18. Scolex. 19. Tentacle, basal region, internal surface, showing V-shaped area at base, free of hooks. 20. Entire tentacle, bothridial surface. 21. Series of alternate hooks of a single file in profile showing variation in size. 22. Sheath and bulb showing origin of retractor muscle at junction of wide and narrow regions of sheath. Specimens from *Carchardon carcharias* (Linnaeus, 1758) (AHC 24933). Scale bars: Figures 18, 22, 1.0 mm; Figures 19–21, 0.1 mm.

related congeners on the basis of characteristics with which it is currently compared.

Family HEPATOXYLIDAE Dollfus, 1940

Genus *Hepatoxylon* Bosc, 1811

This genus contains two species which are cosmopolitan (Dollfus 1942), though Yamaguti (1959) and Schmidt (1986) considered them synonymous. Sin *et al* (1992) have recently provided electrophoretic as well as morphological evidence that the two species are valid.

Hepatoxylon trichiuri (Holten, 1802)
(Figs 18–21, 56–57)

Synonymy — see Dollfus (1942)

Material examined

Adults. From *Carcharodon carcharias* (Linnaeus, 1758): 2 specimens, Dangerous Reef, S.A. (AHC 24933); 4 specimens, Seal Rocks, Phillip Is., Vic. (AHC 24934). From *Isurus oxyrinchus* Rafinesque, 1810: 2 specimens, Southern Australia (coll. RJGL).

Metacestodes. From *Xiphias gladius* Linnaeus, 1758: 1 specimen, Cronulla, N.S.W. (AHC 71, 1407, S2561, S2531, 17593); 6 specimens, Port River, S.A. (AHC 6668). From *Cyttus traversi* (Hutton, 1872): 1 specimen, west coast, Tasmania (Coll. RJGL). From *Coryphaena hippurus* Linnaeus, 1758: 1 specimen, Barwon Banks, 20 miles NE of Mooloolaba, Qld. (AHC 18499). From *Hoplostethus atlanticus* Collet, 1889: 1 specimen, west coast of New Zealand (QM G212141). From *Rexea solandri* Cuvier, 1831: 2 specimens, Great Australian Bight (QM G211886), 1 specimen, south-eastern Tasmania (QM G211887). From *Macruronus novaezelandiae* (Hector, 1871): 2 specimens, west coast of Tasmania (QM G212137).

Remarks

Records of this species from the Australian region are few, being those of Korotaeva (1974) from *Oplegnathus woodwardi* (Waite, 1900) (Syn. *Ostorhynchus conwaii* (Richardson, 1840)), Korotaeva (1971) from *Lepidopus caudatus* (Euphrasen, 1788) (syn *Lepidopus lex* Phillips, 1932) and Lester *et al.* (1988) from *Hoplostethus atlanticus* Collett, 1889 from southern Australia as well as a record from a lamprey, *Geotria*

australis Gray, 1851 by Lethbridge *et al.* (1983). The present data therefore greatly extend the known host range of this species in Australian waters.

The species occurs in a range of teleosts and elasmobranchs in New Zealand waters (Robinson 1959; Waterman & Sin 1991), but the definitive host in the Australasian region has not been reported previously. The parasite is reported here for the first time from *Carcharodon carcharias* and *Isurus oxyrinchus*. The adult has been described by Lönnberg (1899), Joyeux and Baer (1934, 1936) and Yamaguti (1934), the details of which were summarised by Dollfus (1942). The histological anatomy of the plerocercus has been described in considerable detail by Rees (1941) under the name *Dibothriorhynchus grossum* (Rudolphi, 1819). The arrangement of hooks in the metabasal region is quincunxial (see Figs 56, 57) and on the bothridial surface, this pattern extends to the base (Fig. 57). On both the internal and external tentacle surfaces (Fig. 56), the ascending rows of hooks leave an inverted V-shaped area at the base of the tentacle, analogous to the arrangement seen in *T. coryphaenae*. This area is only clearly visible in tentacles dissected free from the scolex, and when this is done, it is extremely difficult to determine orientation of surfaces. Orientation in this case has been determined by analogy with *T. coryphaenae* and from one flattened, stained whole mount in which all the hooks are visible (AHC S2351). It has been assumed that flattening has not altered the arrangement of the hook rows.

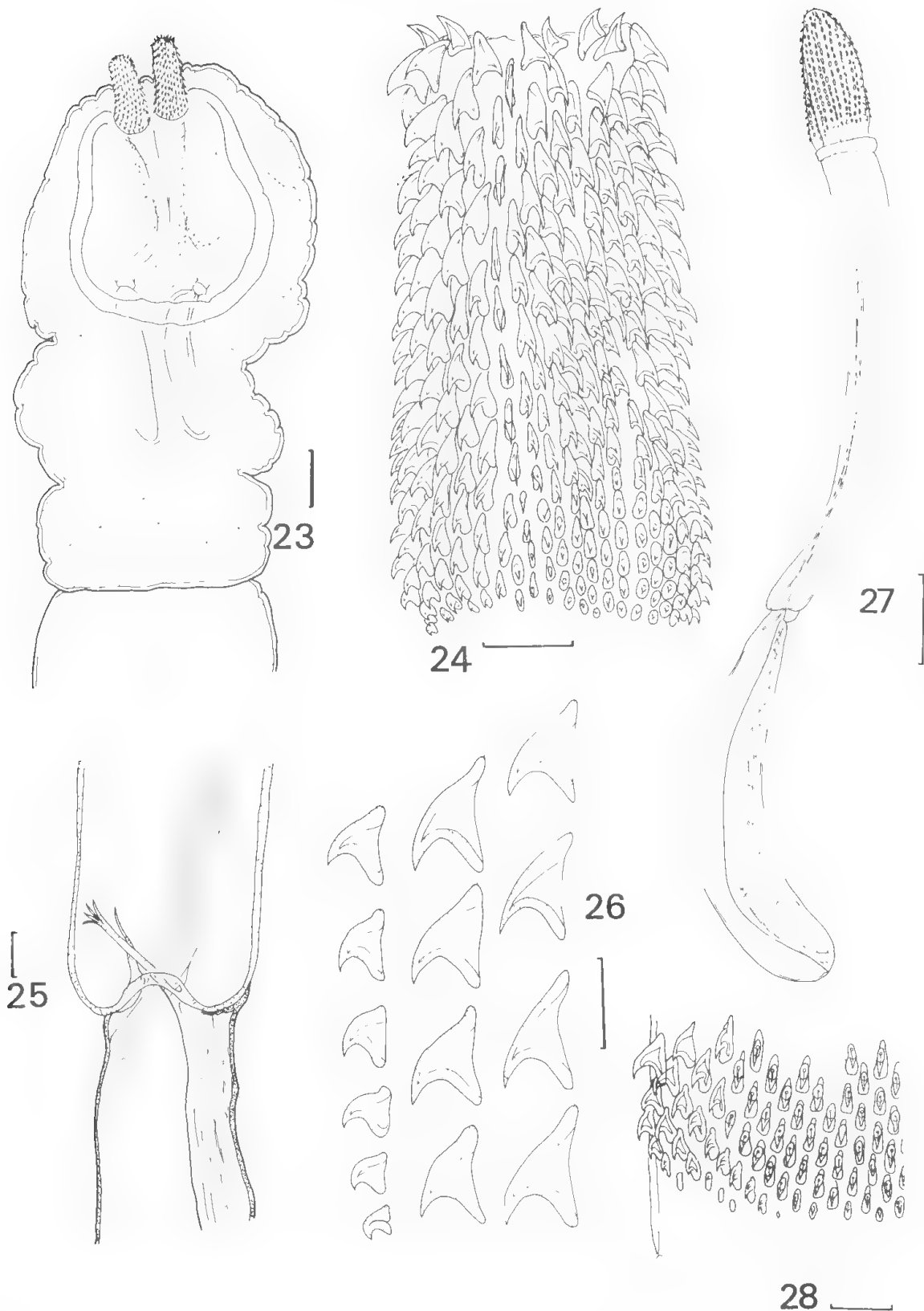
Hepatoxylon megacephalum (Rudolphi, 1819)
(Figs 23–28, 58–59)

Synonymy — see Dollfus (1942)

Material examined

Adults. From *Carcharodon carcharias* (Linnaeus, 1758): 3 specimens, Kangaroo Island, S.A. (AHC 24932).

Metacestodes. From *Galeorhinus galeus* (Linnaeus, 1758): 1 specimen, Kangaroo Island, S.A. (AHC 17591); 1 specimen, Pt. Willunga, S.A. (AHC 593, S2564); 1 specimen, coast of N.S.W. (AM W 3452). From *Carcharhinus obscurus* (LeSueur, 1818) (Syn. *C. macrurus* (Ramsay & Ogilby, 1887): 2 specimens, Glenelg, S.A. (AHC 585, S2565). From *Squalus megalops* (Macleay, 1881): 2 specimens, south coast of N.S.W. (AM W 3359, W 3453). From *Squatina*



FIGURES 23–28. *Hepatoxylon megacephalum* (Rudolphi, 1819). 23. Scolex. 24. Entire tentacle, internal surface, showing V-shaped area at base, free of hooks. 25. Junction of sheath and bulb, showing origin of retractor muscle. 26. Series of single file of hooks in profile showing size variation. 27. Rhyncheal system. 28. Base of tentacle, bothridial view, internal surface to left, showing ascending rows of hooks around unarmed region at base. Specimens from *Carcharodon carcharias* (Linnaeus, 1758) (AHC 24932); Fig. 28 from *Galeorhinus galeus* (Linnaeus, 1758) (AHC 17591). Scale bars: Figures 23, 27, 1.0 mm; Figure 24, 0.2 mm; Figures 25, 26, 28, 0.1 mm.

australis Regan, 1906: 2 specimens, N.S.W. Tasmania (QM G212133–5).
(AM W 3358)

Remarks

This species has not apparently been reported previously from Australia (see Beumer *et al* 1982) though it is well represented in museum collections. Plerocerci were found in several species of elasmobranchs, while the only adults seen were from *Carcharodon carcharias*.

The morphology of the plerocercus has been summarised by Dollfus (1942), with scanning electron microscopical observations by added Sin *et al* (1992), while the adult has been described from *C. carcharias* from New Zealand by Robinson (1959).

The rhyncheal system of this species has apparently not been described in detail. It appears to differ from that of *H. trichiuri* in that the sheaths are not divided into a distal region of greater diameter than the proximal section and in that the retractor muscle originates from the sheath close to the bulbs, rather than at the junctions of the two distinct regions of the sheath noted in *H. trichiuri* (see Rees, 1941).

As with *H. trichiuri*, *H. megacephalum* has an armature arranged in quincunxial fashion in the metabasal region, but with ascending hook rows leaving hook-free triangular areas at the base of the tentacle on the internal and external surfaces. The hook patterns in the metabasal region are not totally regular and if hook files are traced; several files from the base disappear in the metabasal region. The disappearance of files has been noted previously in the armature of *Sphyrrocephalus dollfusi* by Bussieras and Aldrin (1968), though in that species, the arrangement of abbreviated files is symmetrical about the plane drawn through the mid-region of the external surface of the tentacle. In *H. megacephalum*, no symmetry in the reduction of hook files was noted.

Family SPHYRIOCEPHALIDAE Pintner, 1913

Genus *Sphyrrocephalus* Pintner, 1913

Sphyrrocephalus tergestinus Pintner, 1913
(Figs. 29 – 32, 60)

Synonymy — see Dollfus (1942)

Material examined

Metacestodes. From *Macruronus novaezelandiae* (Hector, 1871): 2 specimens,

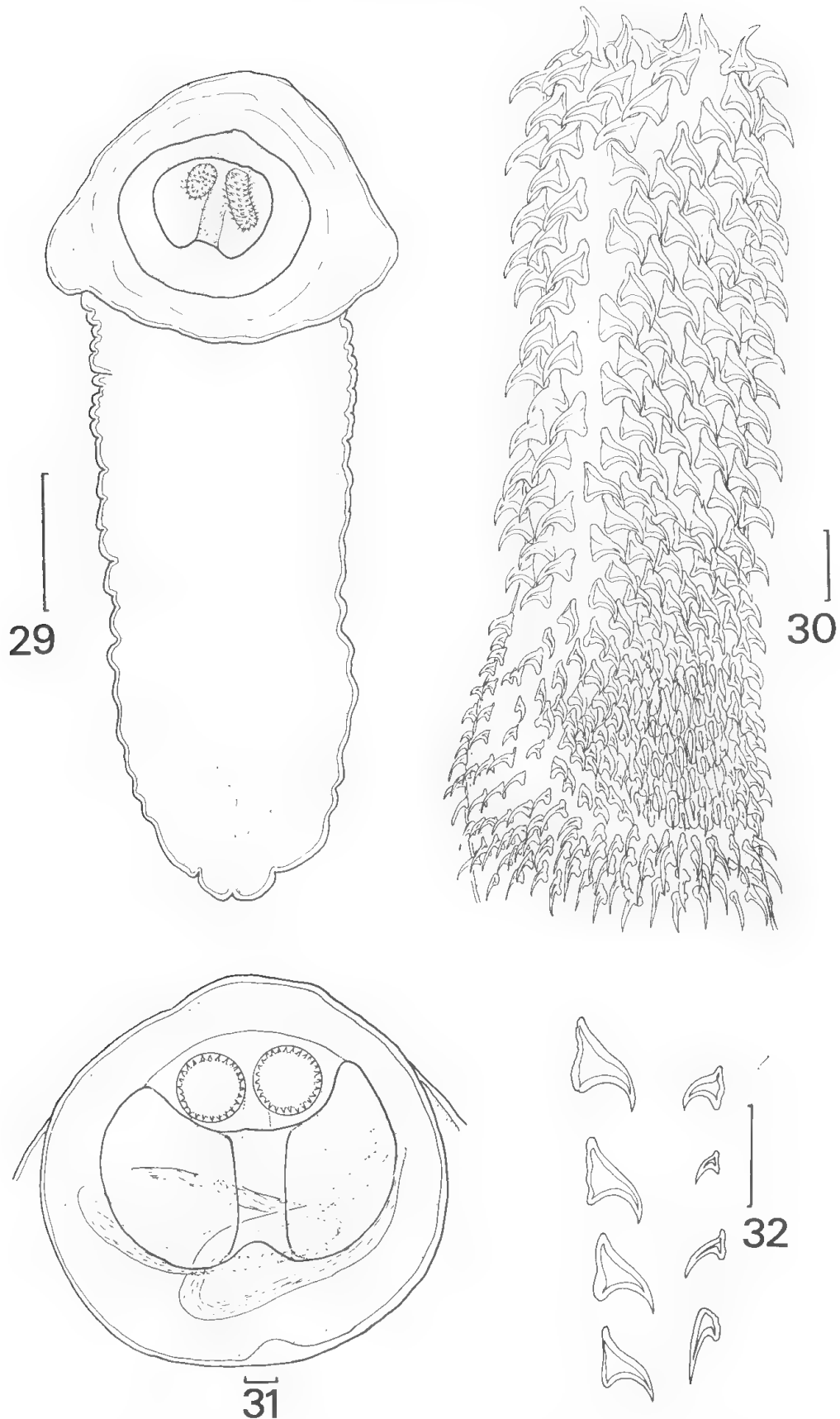
Remarks

The family Sphyrrocephalidae has not previously been reported from Australian waters. The specimens illustrated here are tentatively referred to *S. tergestinus*, contingent upon subsequent clarification of the validity of species within the genus. Dollfus (1942) recognised two valid species, *S. viridis* and *S. tergestinus*, and listed (p. 116) a series of criteria by which the two could be distinguished. His synonymies assumed *S. alberti* to be a synonym of *S. viridis*, a situation subsequently confirmed by Bussieras (1970) who re-examined the types of *S. alberti*. The detailed descriptions of the armature of *S. alberti* given by Bussieras (1970) are the most detailed and informative descriptions of armature within the genus. Heinz and Dailey (1974) gave a very brief description of *S. pelorosoma* from *Alopias superciliosus* (Lowe, 1839) from California, based on a single specimen. The principal features they used for distinguishing their new species were the greater widths of the tentacles and relatively longer bulbs (Heinz & Dailey 1974). The latter character must remain questionable until measurements for *S. viridis* and *S. tergestinus* are available. Dollfus (1942) cited Pintner (1913) in reporting that the bulbs of *S. tergestinus* were twice as long as wide, yet illustrated them (Fig. 72) as being four times as long as wide. The value of this character in distinguishing species therefore remains uncertain until the extent of variation is established for *S. viridis* and *S. tergestinus*.

Bussieras and Aldrin (1968) described *S. dollfusi* based on plerocerci from tuna, *Thunnus obesus* (Lowe, 1839), distinguished from *S. tergestinus* and *S. viridis* in lacking a unique basal armature and having broad tentacles, similar in width to those of *S. pelorosoma*.

The specimens described here differ from *S. viridis* and *S. dollfusi* in that the sheaths are confined within the pars bothridialis. The specimens described conform with the description given by Dollfus (1942) of *S. tergestinus* and are therefore attributed to that species.

Bussieras (1970) noted that the armature of the metabasal region of the tentacle of *S. viridis* (= *alberti*) was arranged in an heteroacanthous pattern rather than an homeoacanthous pattern and questioned whether or not this was a specific characteristic. Although the current material of *S. tergestinus* is limited, it appears that it also has



FIGURES 29–32. *Sphyricephalus tergestinus* Pintner, 1913. **29.** Plerocercus. **30.** Oblique view of tentacle with bothridial surface to lefthand side. **31.** Scolex of plerocercus, showing bulbs in transverse position, overlapped by the pars bothridialis. **32.** Tentacular hooks showing variation in shape between those of metabasal region (left file) and basal region (right file). Specimens from *Macruronus novaezelandiae* (Hector, 1871) (QM G212133–5).

glide reflection symmetry (Campbell & Beveridge 1994) in the arrangement of its armature in the metabasal region.

Superfamily OTOBOTHRIOIDEA Dollfus, 1942

Family OTOBOTHRIIDAE Dollfus, 1942

Genus *Poecilancistrum* Dollfus, 1929

Poecilancistrum caryophyllum (Diesing, 1850)
(Figs 33–47)

Synonymy — see Dollfus (1942)

Material examined

Adults. From *Carcharhinus brachyurus* (Guenther, 1870): 8 specimens, Tathra, N.S.W. (AHC 24957);

Metacestodes. From *Pomatomus saltatrix* (Linnaeus, 1766): 3 specimens, Pt Jackson, N.S.W. (AHC 1410, S2563). From *Sillago robusta* Stead, 1908: 3 specimens, Qld. (QM G212164).

Description

Cestodes of moderate size, up to 170 long, with up to 280 proglottides in gravid strobilae. Scolex 3.9–4.6 (3.3) (n=8) long, maximum width 1.1–1.4 (1.3) (n=8) in region of pars vaginalis; 2 bothridia, 2.0 (n=1) in diameter; almost circular, with indistinct, fleshy margins; pairs of sensory fossettes present in margin of each bothridium. Pars bothridialis 1.55–2.00 (1.77) (n=8). Pars vaginalis 1.65–2.48 (2.22) (n=8), sheaths not coiled, straight anteriorly, characteristically S-shaped posteriorly; pre-bulbar organ absent, but prominent muscle band encircling junction of sheath with bulb. Bulbs stout, 1.35–1.76 (1.59) (n=8) long by 0.32–0.42 (0.38) (n=8) wide; origin of retractor muscle at anterior end of bulb. Pars post-bulbosa approx. 0.22; velum absent. Tentacles stout, 0.08–0.13 (0.11) (n=7) in diameter in metabasal region, without basal swelling or distinctive basal armature. Armature heteroacanthous, atypical; principal hooks arranged in ascending rows; 4 hooks per row decreasing in size anteriorly; hooks 1(1') largest, 0.114–0.126 (0.120) long, strongly recurved, base prominent, 0.084–0.100 (0.087) long; hooks 2(2') smaller, 0.092–0.098 (0.095) long, base 0.048–0.052 (0.050); hooks 3(3') 0.068–0.082 (0.075) long, base 0.034–0.040 (0.036); hooks 4(4') smallest, 0.054–0.064 (0.061) long, base 0.022–

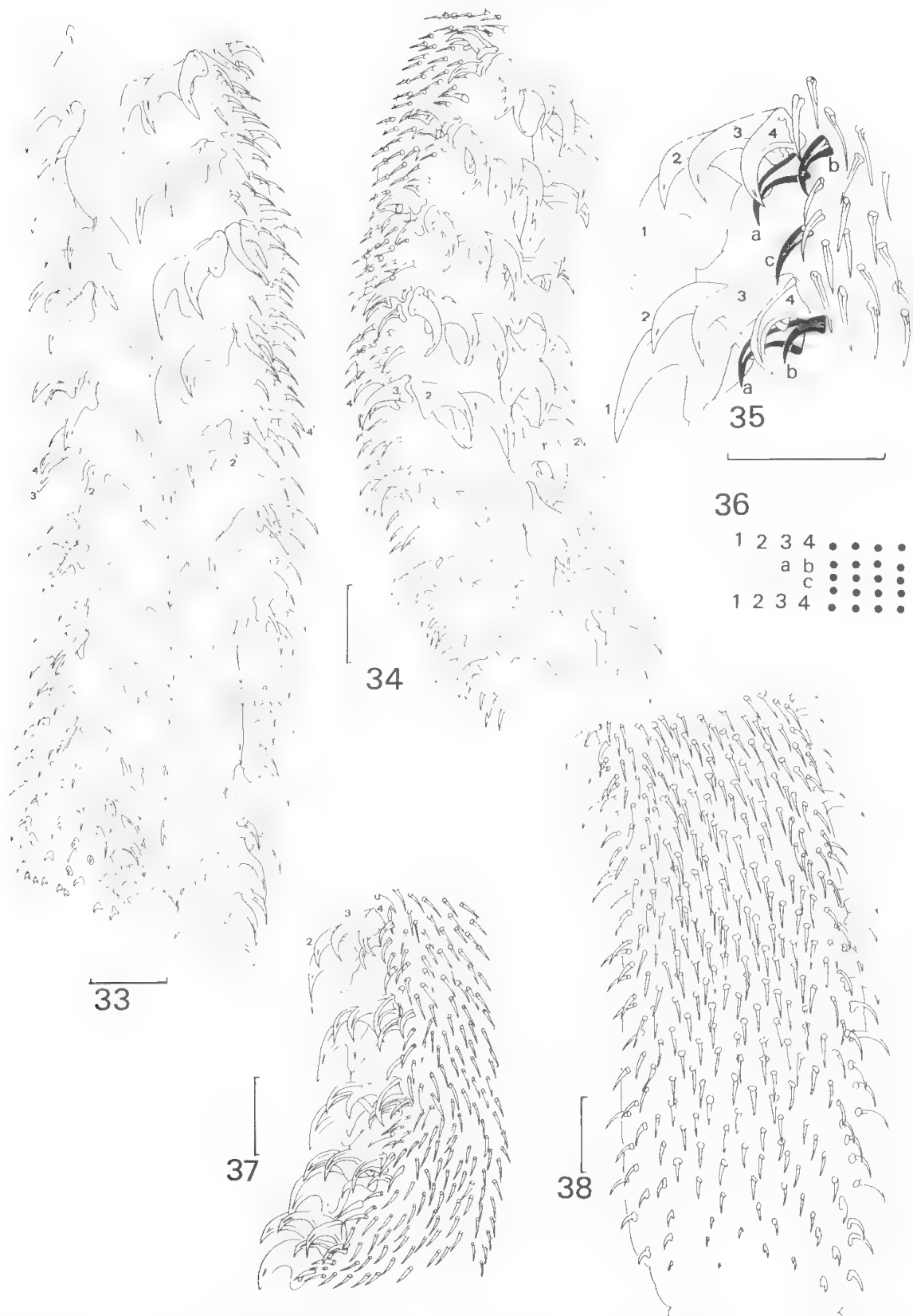
0.032 (0.029).

Single intercalary row of hooks present between each major row; 2, sometimes 3, intercalary hooks per row, situated proximal to hooks 3(3') and 4(4') respectively; intercalary hooks a(a') 0.046–0.054 (0.049) long, hooks b(b') 0.036–0.046 (0.041) long; single hook, c(c') possibly representing second intercalary row, present posterior to other hooks. Internal surface of tentacle uniformly covered with numerous ascending rows of small hooks, 0.030–0.036 (0.034) long. Rows ascending with approximately 14 hooks per row; 4 rows per principal hook row.

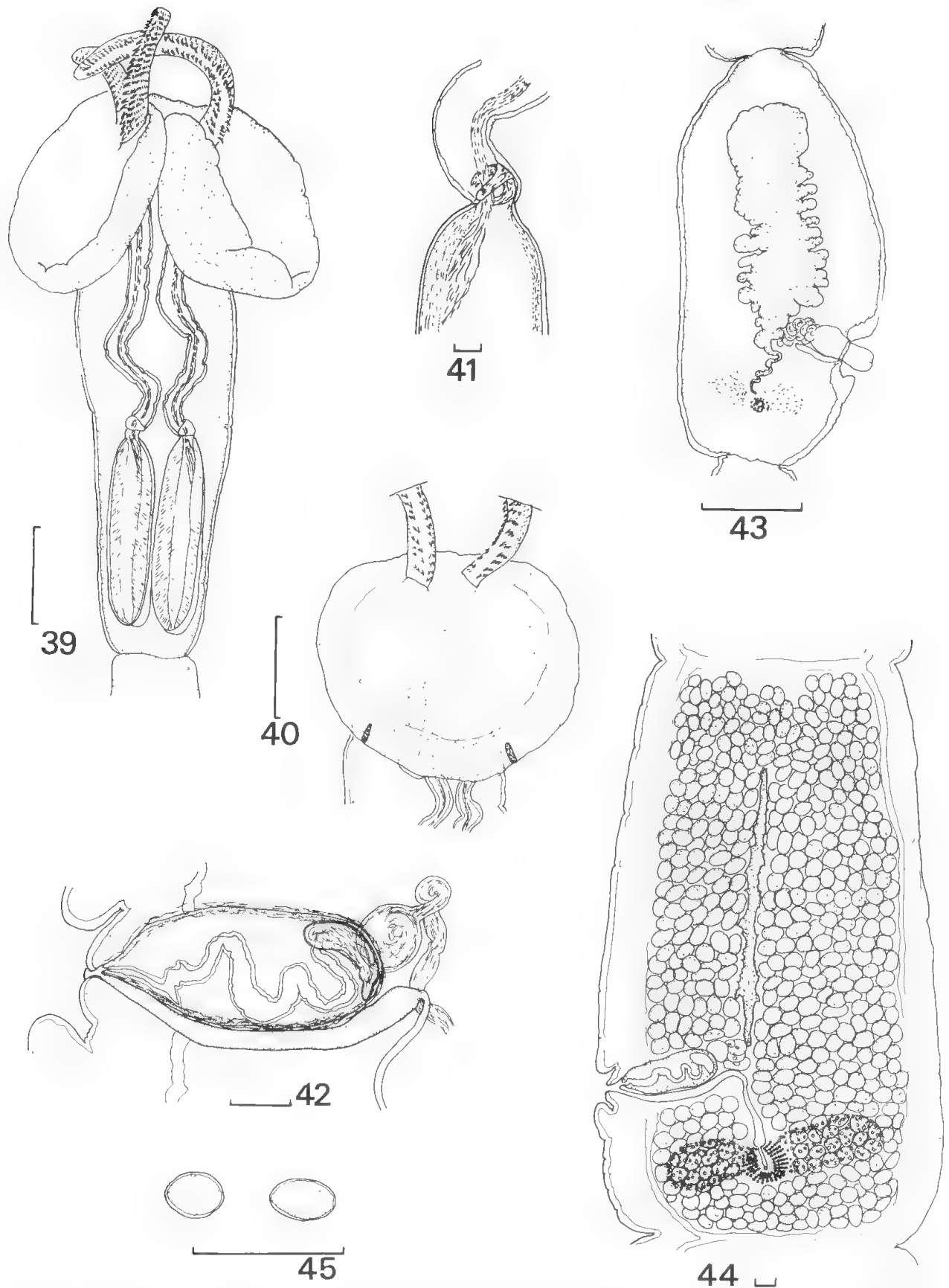
Mature proglottis 1.43–2.02 (1.78) (n=9) by 1.25–1.40 (1.30) (n=9); genital pore in posterior third of proglottis, 1.07–1.50 (1.28) (n=9) from anterior end of proglottis. Cirrus sac pyriform, thin-walled, 0.21–0.28 (0.25) by 0.14–0.19 (0.16); cirrus unarmed, slightly coiled, entering crescentic internal seminal vesicle; external seminal vesicle spherical, adnate to cirrus sac. Vas deferens coils posteriorly to region of ovary. Testes numerous, 550 (n=1) per proglottis, occupying entire medulla in single dorso-ventral layer; testis diameter 0.045–0.065 (0.053). Vagina opens to genital atrium posterior to cirrus sac; narrow, turning posteriorly at midline and descending towards ovary, dilating slightly at posterior end, but not forming distinct seminal receptacle. Ovary bilobed, each lobe 0.30–0.50 (0.45) by 0.20–0.28 (0.25); Mehlis' gland 0.15–0.19 (0.17) in diameter, posterior to ovarian isthmus. Uterine duct, without glandular investment, ascends to just anterior to cirrus sac; uterus with glandular wall extends anteriorly, not reaching anterior end of proglottis. Gravid proglottis 3.0 to 3.2 by 1.0 to 1.5; uterus initially linear, becoming sacciform with numerous small lateral branches; eggs ellipsoidal approx. 0.036 by 0.026; uterine pore absent. Vitelline follicles forming sleeve encircling reproductive organs.

Remarks

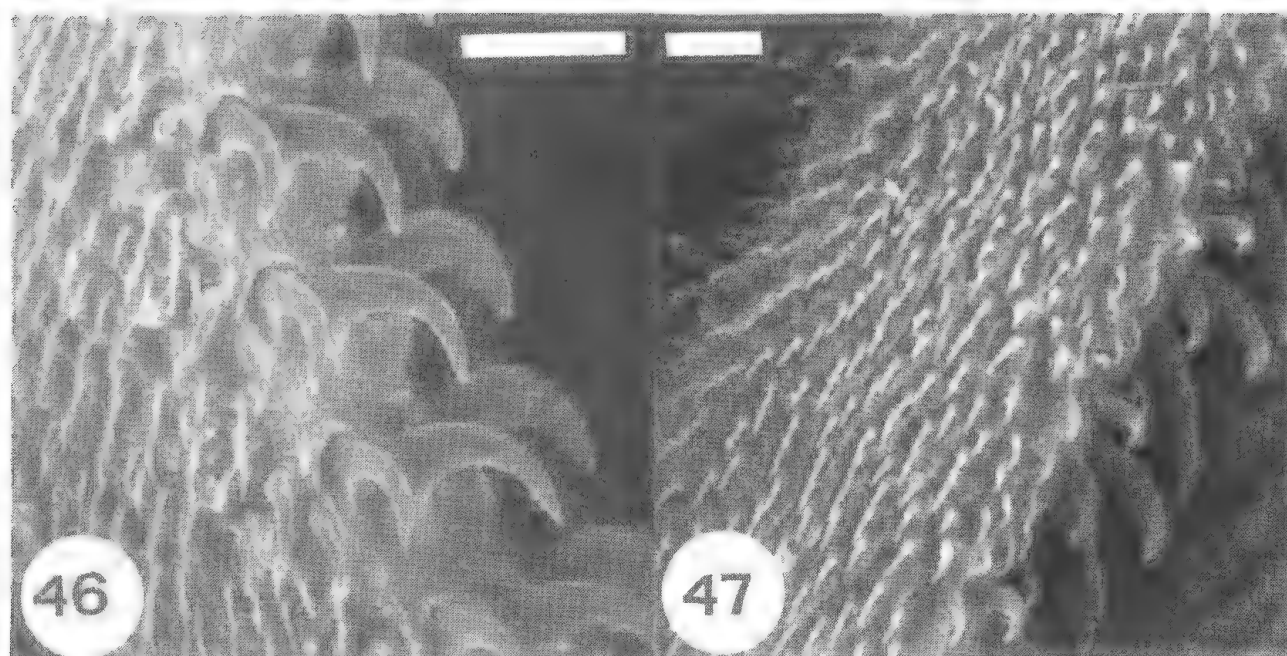
In spite of its cosmopolitan distribution, the anatomy of this species is relatively poorly known. The first report from Australia was that of Robinson (1965), who described plerocerci from *Argyrosomus hololepidotus* (Lacépède, 1802) (syn. *Sciaena antarctica* Castlenau, 1872) from New South Wales. The adult stage had been described earlier by Goldstein (1962, 1963) from American sharks. Robinson (1965) compared his specimens with those of Goldstein (1963). The armature of this species has recently been



FIGURES 33–38. *Poecilancistrum caryophyllum* (Diesing, 1850). Tentacular armature. **33.** Basal and metabasal region, internal surface. **34.** Metabasal region, bothridial surface. **35.** Two principal hook rows showing relationships between intercalary hooks and band of hooklets. **36.** Schematic representation of hook arrangements. Numerals indicate hooks of principal rows, letters are intercalary hooks; circles represent hooklets of external surface. **37.** Basal region, bothridial surface. **38.** Basal and metabasal regions, external surface. Specimens from *Carcharhinus brachyurus* (Guenther, 1870) (AHC 24957). Scale bars: 0.1 mm.



FIGURES 39–45. *Poecilancistrum caryophyllum* (Diesing, 1850). 39. Scolex. 40. Bothridium. 41. Junction of sheath and bulb showing origin of retractor muscle. 42. Cirrus sac. 43. Gravid proglottis. 44. Mature proglottis. 45. Eggs. Specimens from *Carcharhinus brachyurus* (Guenther, 1870) (AHC 24957). Scale bars: Figures 39, 40, 43, 1.0 mm; Figures 41, 42, 44, 45, 0.1 mm.



FIGURES 46–47. *Poecilancistrum caryophyllum* (Diesing, 1850). Scanning electron micrographs of armature. 46. Bothridial surface, metabasal region, showing junction of principal rows of hooks with band of hooklets on external surface. 47. External surface, metabasal region showing band of hooklets. Specimens from *Carcharhinus brachyurus* (Guenther, 1870). Scale bars: 0.1 mm.

redescribed by Palm (1995) based on specimens from Atlantic teleosts.

The present description of the adult provides additional information, in demonstrating the presence of a crescentic internal seminal vesicle, a circular external seminal vesicle adnate to the cirrus sac and in describing the morphology of the gravid uterus.

The most significant aspect of the current redescription is the oncotaxy. Although adequately described by Robinson (1965), the only attempt to interpret the pattern of hooks is that of Campbell and Beveridge (1994) and Palm (1995). The external surface of the tentacle of *P. caryophyllum* is covered by a band of small hooks. The features not noted in previous descriptions are associated with the regularity of arrangement of the small hooks comprising the band. They are arranged in ascending rows, with four between each principal row, and with the ascending rows terminating in the midline of the external surface. Some minor departures from the regular pattern are detectable, with the presence of an occasional hook which does not fit within a row. However, these irregularities are rare, and at the base of the tentacle the hook files form a convergence as seen in typical heteroacanthous armature patterns.

Superfamily POECILACANTHOIDEA Dollfus, 1942

Family LACISTORHYNCHIDAE Guiart, 1927

Genus *Callitetrarhynchus* Pinter, 1931

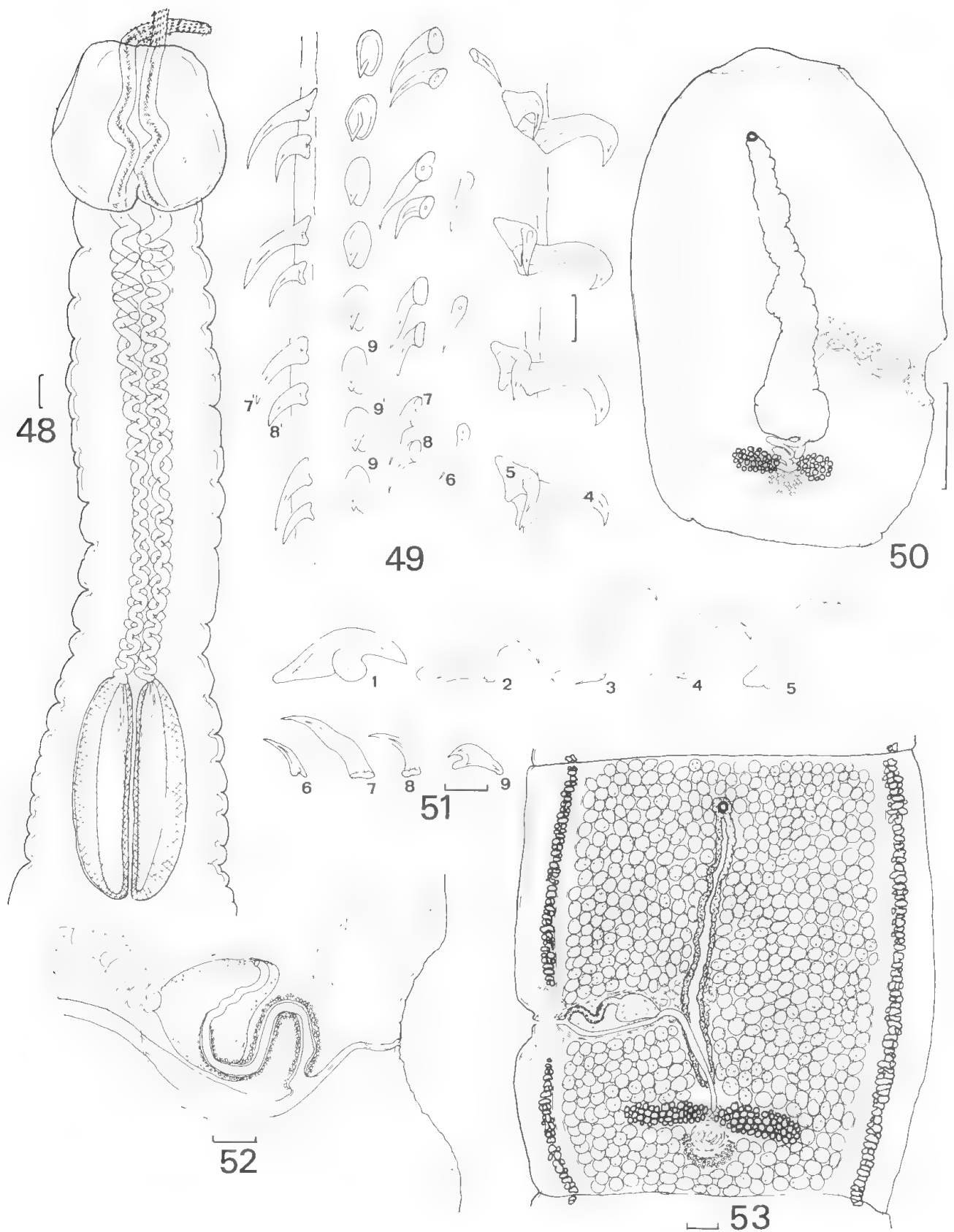
The genus was considered monotypic by Dollfus (1942). However, Carvajal and Rego (1985) have shown that Dollfus' description is a composite of *C. gracilis* and *C. speciosus*. Only *C. gracilis* has been found in Australian fishes to date.

Callitetrarhynchus gracilis (Rudolphi, 1819)
(Figs 48 – 53)

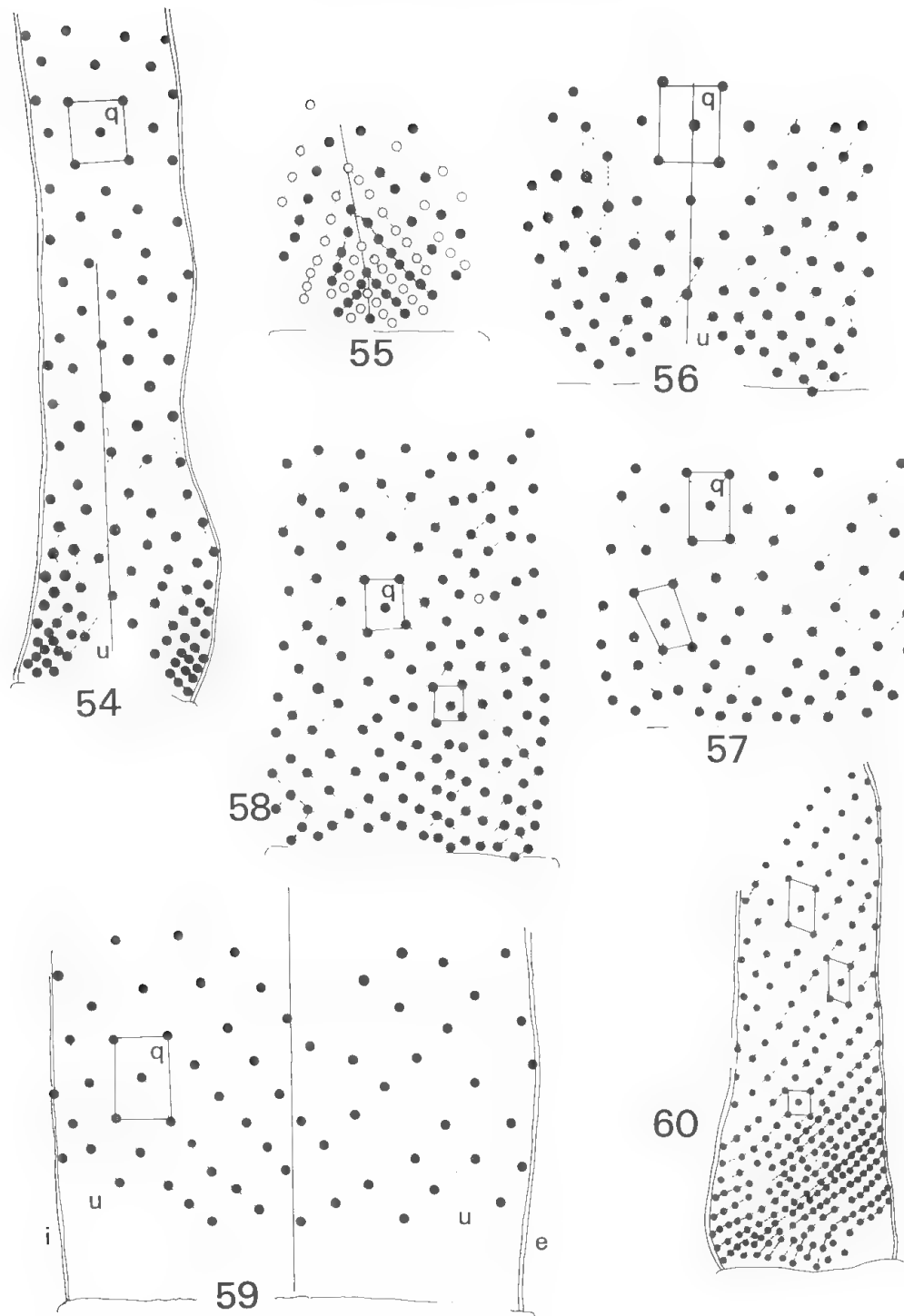
Synonymy — see Dollfus (1942)

Material examined

Adults. From *Carcharhinus amblyrhynchoides* (Whitley, 1934): 1 specimen, Snapper Island, Qld. (AHC 24941). From *Carcharhinus melanopterus* (Quoy & Gaimard, 1824): 3 specimens, Flat Top Island, Qld. (AHC 24940); 1 specimen, Darwin, N.T. (AHC 24939). From *Carcharhinus amboinensis* (Mueller & Henle, 1839): 1 specimen, Mary River, N.T. (AHC



FIGURES 48–53. *Callitetrarhynchus gracilis* (Rudolphi, 1819). 48. Scolex. 49. Tentacular armature, metabasal region, external surface. 50. Gravid proglottis. 51. Profiles of hooks 1–9. 52. Terminal genital ducts showing cirrus and vagina uniting within 'cirrus sac' to form a short hermaphroditic duct. 53. Mature proglottis. Specimens from *Carcharhinus fitzroyensis* (Whitley, 1943) (AHC 24937). Scale bars: Figures 48, 52, 53, 0.1 mm; Figures 49, 51, 0.01 mm; Figure 50, 1.0 mm.



FIGURES 54–60. Schematic arrangements of hook patterns. **54.** *Tentacularia coryphaenae*. Basal and metabasal regions, internal surface, showing ascending hook rows and V-shaped unarmed area (u) at base of tentacle. Hooks of metabasal region are arranged in quincunxes (q). Derived from Fig. 2. **55.** *Tentacularia coryphaenae*. Basal region bothridial surface (from Fig. 3), showing ascending rows of hooks. **56.** *Hepatoxylon trichiuri*. Basal and metabasal regions, internal surface (from Fig. 19), showing V-shaped unarmed area at base of tentacle (u) and quincunxial arrangement of hooks (q) in metabasal region. **57.** *Hepatoxylon trichiuri*. Basal and metabasal region, bothridial surface, showing quincunxial hook arrangement (q) (from Fig. 20). **58.** *Hepatoxylon megacephalum*. Basal and metabasal region, internal surface (from Fig. 24) showing quincunxial hook arrangement (q). **59.** *Hepatoxylon megacephalum*. Basal region, bothridial surface, showing ascending hook rows which form V-shaped unarmed areas (u) on internal (i) and external (e) surfaces and quincunxial hook arrangement (q). **60.** *Sphyriocephalus tergustinus*. Oblique view with bothridial surface to left (from Fig. 30) showing hooks arranged in ascending spiral rows in typical heteroacanthous pattern.

24938). From *Carcharhinus fitzroyensis* (Whitley, 1943): 6 specimens, Darwin N.T., (AHC 24937); 5 specimens, Mary River, N.T. (AHC 24936). From *Dasyatis fluviorum* Ogilby, 1908: 1 specimen, Moreton Bay, Qld. (AHC 24942).

Metacestodes. From *Sphyræna novaehollandiae* Günther, 1860: Brighton, S.A. (AHC S539); Outer Harbour, S.A. (BMNH 1986. 10.1.2). From *Pristipomoides multidens* (Day, 1870): 1 specimen, Bathurst Island, N.T. (AHC 24943). From *Makaira indica* (Cuvier, 1832): 1 specimen, Cape Bowling Green, Qld. (AHC 17410); 5 specimens, Pixie Reef, Cairns, Qld. (AHC 17417). From *Makaira mazara* (Jordon & Snyder, 1901): 1 specimen, Cape Moreton, Qld. (QM G212785). From *Istiophorus platypterus* (Shaw & Nodder, 1791): 3 specimens, Cape Moreton, Qld. (AHC 18496); 2 specimens, Beaver Cay, Qld. (AHC 18495). From *Euthynnus affinis* (Cantor, 1849): 1 specimen, Cape Moreton, Qld. (AHC 18493). From *Saurida tumbil* (Bloch, 1795): 1 specimen, Moreton Bay, Qld. (Coll. RJGL). From *Scomberomorus commerson* (Lacépède, 1800): 1 specimen, Pt Lookout, Qld. (Coll. RJGL). From *Scomberomorus munroi* Collette & Russo, 1980: 3 specimens, Amity Pt, Qld. (Coll. RJGL). From *Platycephalus fuscus* Cuvier, 1829: 1 specimen, Moreton Bay, Qld. (QM G212172). From *Arripis trutta* (Bloch & Schneider, 1801): 3 specimens, Phillip Island, Vic. (AHC 24944). From *Arripis truttaceus* (Cuvier, 1829): 1 specimen, Phillip Island, Vic. (AHC 24945).

Remarks

This cosmopolitan species has previously been reported from Australia only by Prudhoe (1969) from *Platycephalus bassensis* Cuvier, 1829 from Tasmania and by Adjei *et al* (1986) from *Saurida tumbil* (Bloch, 1795) and *S. undosquamis* (Richardson, 1848) from Queensland. The identification of the Queensland specimens was confirmed, however, the Tasmanian specimens (SAM V604) on re-examination proved to be *Floriceps minacanthus* Campbell & Beveridge,

1986, and have not therefore been included in the list of material examined. The scolex and armature of *C. gracilis* were well described by Dollfus (1942) but unfortunately, the description was a composite of *C. gracilis* and *C. speciosus*. The scolex and armature of both species were illustrated and described by Carvajal and Rego (1985). The adult was described very briefly under the name *Tentacularia pseudodera* by Shuler (1938). A more complete description was provided by Subhapradha (1955). It is clear from Subhapradha's figures of the armature that the specimens described are indeed *C. gracilis* rather than *C. speciosus*, since hooks 7(7') are much longer than hooks 8(8'). However, Subhapradha's (1955) description needs to be amended at three points. Firstly, a muscular pad surrounds the genital atrium (Fig. 53). This very prominent feature was not mentioned or illustrated by Subhapradha (1955). Secondly, an hermaphroditic duct is present (Fig. 52). The vagina enters the cirrus sac (actually an hermaphroditic sac) on its medio-ventral aspect then runs within the sac the join with the cirrus leaving a short hermaphroditic duct to enter the genital atrium. The presence of a hermaphroditic duct was first reported by Beveridge and Campbell (1989) and was illustrated by them subsequently (Campbell & Beveridge 1994). All known genera with chainettes and two bothridia have hermaphroditic ducts (Beveridge & Campbell 1989). Thirdly, a uterine pore is present. This feature was not included in the generic diagnosis given by Campbell and Beveridge (1994).

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THE GENUS SELENARIOPSIS MAPLESTONE, 1913 (BRYOZOA, ASCOPHORINA)

P. E. BOCK & P. L. COOK

Summary

Lunulitiform colonies of *Selenariopsis* are a frequent component of the microfauna inhabiting the surface and upper layers of the deeper shelf sediments off the southern and eastern coasts of Australia. Colonies are anchored by rhizoids originating from special porous areas on the exposed basal walls. Although colonies are fragile, fragmented specimens are present as fossils in the clay-rich marine Tertiary sediments of Victoria and South Australia. Tertiary colonies include two taxa, *S. macgillivrayi* sp. nov. and *S. marginata* sp. nov., both of which are distinct from the Recent form, *S. gabrieli* Maplestone, 1913. Full descriptions and a key to all three species are given below.

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BOCK, P. E. & COOK, P. L. 1996. The Genus *Selenariopsis* Maplestone, 1913 (Bryozoa, Ascophorina) *Records of the South Australian Museum* 29(1): 23–31.

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The distinctive 'sand fauna' species *Selenariopsis gabrieli* Maplestone, 1913 has been reported several times from the coasts of New South Wales, Western Australia and South Australia, as well as from Bass Strait. Colonies live in or upon the upper layers of sediment and have been reported previously from 54–366 m deep (see Cook & Chimonides 1981a, and Wass & Yoo 1983). Colonies are lunulitiform and live anchored by large basal rhizoids. *Selenariopsis* has been reported from the Tertiary of Victoria, as *?Lunulites angulopora* by MacGillivray (1895), and this record has usually been included in the synonymy of *S. gabrieli*, the Recent form (see Powell 1966; Cook & Chimonides 1981a). Examination of Recent specimens of *S. gabrieli*, and analysis of numerous Tertiary samples from Victoria and South Australia has revealed the presence of two additional species neither of which is *S. gabrieli*. One appears to be the *?Lunulites angulopora* of MacGillivray (1895), the other is described for the first time below.

MATERIALS AND METHODS

Abbreviations of institutions referred to in this paper are: MV, Museum of Victoria, Melbourne; AM, Australian Museum, Sydney; SAM, South Australian Museum, Adelaide. Specimens were coated with gold for scanning electron microscopy.

SYSTEMATICS

Order Cheilostomatida Busk, 1852

Suborder Ascophorina Levinsen, 1909

Super Family CATENICELLOIDEA Busk, 1852

Family EURYSTOMELLIDAE Levinsen, 1909

Cook and Chimonides (1981a) referred *Selenariopsis* to an informal grouping of genera, the Gymnocystidean Ascophora, based on the nature of the calcified frontal shield. Relatively few genera are known to have gymnocystidean ontogeny, and these are not closely related systematically to one another. Several gymnocystidean genera have been discussed by Gordon (1984, 1989), and referred to different superfamilies.

The affinities of the Eurystomellidae are somewhat problematical. *Eurystomella bilabiata* (Hincks) and *Selenariopsis gabrieli* Maplestone have completely non-porous, gymnocystidean frontal shields, the only areas of cryptocyst occurring as proximo-lateral embayments at the edges of the orifice, which appear to be associated with the hinging of the operculum (see Cook & Chimonides 1981a). *E. foraminigera* (Hincks) has, however, a shield with large, cuticle-covered, cryptocyst-bordered foramina (see Cook & Chimonides 1981a and Gordon 1984). The



ovicells of all three species are endozooidal, the brooding zooid having an enlarged, dimorphic orifice, which in *S. gabrieli* is closed by the operculum. The ovicell cavities are associated with a distal autozooid or kenozooid. The frontal ectooecium has one or more areas of cuticle-covered entoecium and a median suture. There are similarities in both frontal shield and ovicell structure with some members of the family Catenicellidae (see Banta & Wass 1979 and Wass & Banta 1981). Gordon (1984, 1989) has included the Eurystomellidae with the Catenicellidae in the superfamily Catenicelloidea.

Genus *Selenariopsis* Maplestone, 1913

Selenariopsis Maplestone, 1913: 359; Cook & Chimonides, 1981a: 114.

Australiana Powell, 1966: 19.

Diagnosis

Colonies lunulitiform, budded radially. Zooids with imperforate, gymnocystidean frontal shields and sinuate primary orifices. Basal walls with uncalcified windows and porous areas which are the origin of rhizoids in Recent colonies. Ovicells with dimorphic orifice, closed by the operculum, with paired entoecial areas frontally. Avicularia absent.

KEY TO SPECIES

- 1 - Orifices elongated, raised marginally. Ovicell fairly prominent, followed by an autozooid, with extensive, but faintly marked, paired entoecial areas. Basal porous areas usually very small *S. marginata* sp. nov.
- Orifices not raised marginally; basal porous areas larger 2
- 2 - Autozooid frontals oblong. Orifice with a subtriangular sinus. Ovicell depressed distally, followed by an autozooid. Small paired entoecial areas close to median

suture. Basal windows very narrow *S. macgillivrayi* sp. nov.

- Autozooid frontals almost square. Orifice with a wide rounded sinus. Ovicell wide, immersed in a distal kenozooid with paired distal fenestrae. Basal windows oval *S. gabrieli* Maplestone

Selenariopsis gabrieli Maplestone, 1913 (Figs 1, 7)

Selenariopsis gabrieli Maplestone, 1913: 359, pl. 28, figs 6-10; Cook & Chimonides 1981a: 114, Figs 2D, 3, 4E, 5A-C, 9C; Wass & Yoo 1983: 337, Figs 44-46.

Australiana bifenestrata Powell, 1966: 20, pl. 1, figs 1-7, Fig. 1a-i; Cook 1979: pl. 1, figs 12d, e, Fig. 1F.

Material Examined

AM Gabo Island, Victoria, 366 m. MV Kimbla Stn 65D, Bass Strait, 207 m. Kimbla Stn 99, Bass Strait, 139 m. SLOPE Stn 19, off Eden, New South Wales, 520 m. Slope Stn 45, off Freycinet Peninsula, Tasmania, 800 m. Great Australian Bight Stn 030, 33°13'S, 128°29'E, 137 m.

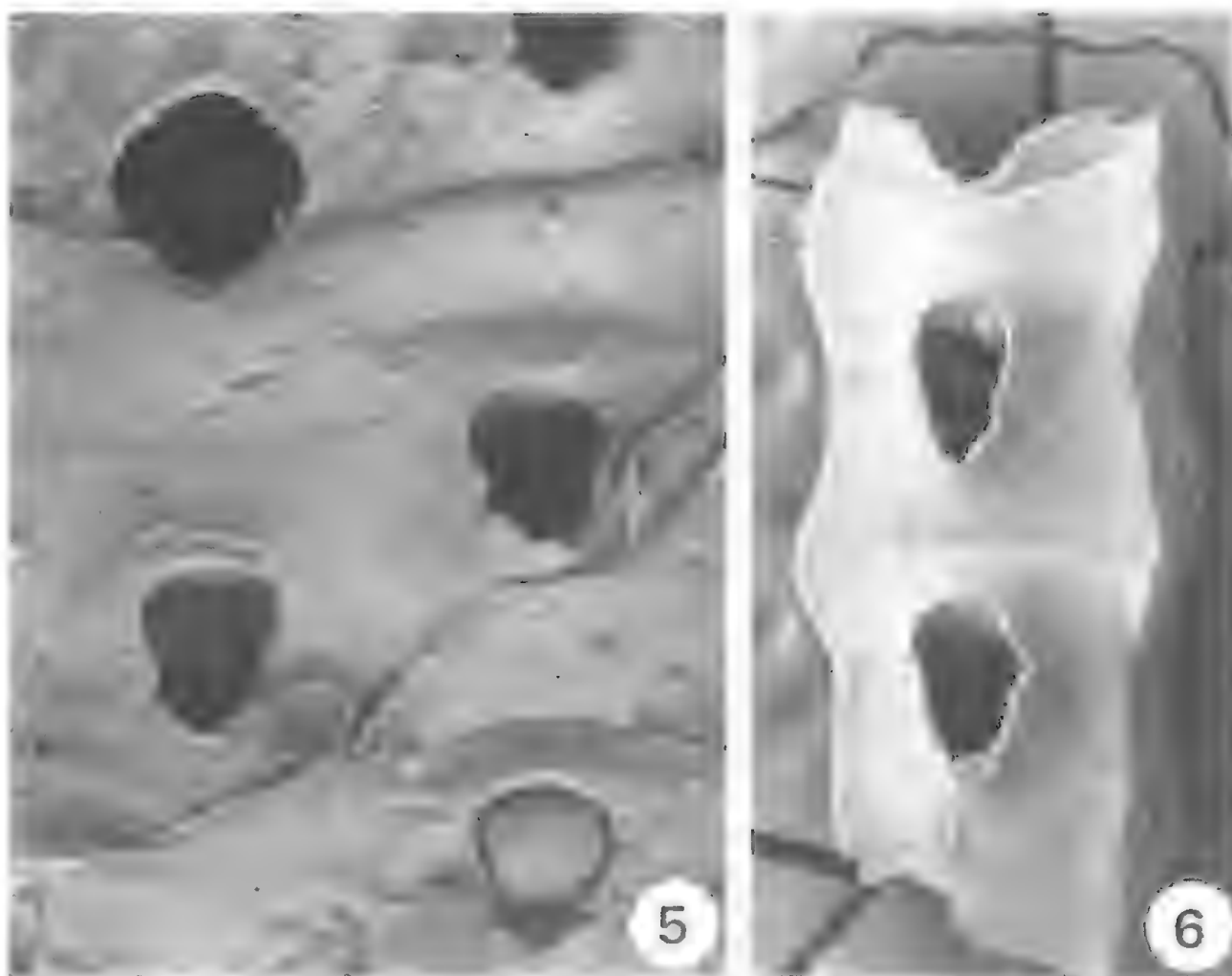
Description

Autozooid with short, almost square frontal shield, orifice nearly central with a short, rounded sinus marked by minute lateral embayments of cryptocyst. Brooding orifice wide, almost semi-circular. Ovicell wide, not prominent, immersed in a distal kenozooid with large, paired, subtriangular entoecial fenestrae on its frontal surface. Basal autozooid windows oval or slightly narrower; those of brooding zooids are very large and subtriangular. The rhizoid windows are a narrow crescent, with a large proximal porous area surrounded by a raised rim. Pores are placed round the edge of the large, rounded to subrectangular area; the rhizoids are large.

Distribution

A. bifenestrata was described by Powell (1966) from Bulgo and from several other New South

FIGURES 1-4. 1, *Selenariopsis gabrieli* Maplestone, Kimbla Stn 99. Autozooids and one brooding zooid with paired distal kenozooidal frontal fenestrae; note 'growth lines', X118; 2, *S. macgillivrayi* sp. nov., Princetown. Autozooids and one brooding zooid with inconspicuous distal ovicell with paired frontal areas (arrowed), X110; 3,4, *S. marginata* sp. nov., Princetown; 3, Brooding zooid with ovicell, frontal areas arrowed; and two autozooids, one showing proximo-lateral embayments (arrowed), and subtriangular sinus, X80; 4, Brooding zooid with ovicell, X80.



FIGURES 5-6 5, *Selenariopsis macgillivrayi* sp. nov., Princetown. Autozooid orifices and one brooding zooid; note 'growth line', X110; 6, *S. marginata* sp. nov., Princetown. Two autozooids showing raised orifices and lateral septular pores, X80.

Wales localities. The records given by Wass and Yoo (1983) extend from Western Australia, near Albany through the Bight to the western end of Bass Strait. The other records given above include one from the Great Australian Bight, and also extend from Bass Strait east to New South Wales, and south to Tasmania. Recorded depths now range from 54 to 800 m.

Remarks

Colonies may reach a diameter of more than 5 mm, and 3.50 mm in height, although the vertical dimension is variable, some colonies being fairly flattened, while others are strongly domed, as illustrated by Powell (1966). Rhizoids are 0.25 mm wide, and may reach more than 3 mm in length; even small colonies usually have several present. The ancestrula has an uncalcified frontal wall and a large, prominent basal pore plate giving rise to a rhizoid. Brooding zooids are scattered and do not appear before the fourth

astogenetic generation. Frontally, the surface of colonies is smooth, even the ovicells hardly protruding. The morphology has been described in great detail by Powell (1966), and the mode of life and the associated fauna in one sample was discussed by Cook (1979). The early astogeny and relationships were described by Cook and Chimonides (1981a). *S. gabrieli* differs from its two fossil congeners in the shape of the orifice, and the structure and relationships of the ovicell.

Selenariopsis macgillivrayi sp. nov. (Figs 2, 5, 8)

?*Lunulites angulopora* MacGillivray, 1895: 46, pl. 8, fig. 1 (not *L. angulopora* Tenison Woods, 1880 = *Conescharella angulopora*).

Material Examined

Holotype: MV P27625, Muddy Creek, Victoria,

Miocene (see Powell 1966); also material from Coorimungle, Balcombe Bay, Grices Creek, Princetown, Gellibrand Clay, Mount Martha, Victoria and Mount Schanck, South Australia (SAM P35472).

Description

Autozooids with almost oblong frontal shield, orifice placed in the distal half, slightly elongated, with a subtriangular sinus. The lateral embayments are very small, reduced to paired notches on the edge of the orifice. The brooding zooid orifice is wide and rounded. The ovicell is almost flat, and the next distal zooid is often crossed by a depressed groove in the calcification. The paired entooecial areas are small and not obvious; they are usually placed close to the median suture. The basal autozooid windows are very narrow, those of brooding zooids are more oval. The rhizoid windows are crescentic, with a large rounded proximal porous area within a raised rim. Pores are placed round the edge of the area.

Etymology

Named for P. H. MacGillivray, who first described the fossil specimens.

Distribution

S. macgillivrayi occurs in Miocene deposits from Mount Schanck in South Australia in the west to the east coast of Port Phillip Bay in Victoria.

Remarks

MacGillivray (1895) was doubtful that his specimen was the same species as that described as *Lunulites angulopora* by Tenison Woods (1880), but did not discuss his reasons. Two of Tenison Woods's species of 'Selenariadae', *L. crassa* and *L. angulopora*, are not lunulitiform and free-living, but belong to the genus *Conescharrellina*. The name '*angulopora*' is not available for *Selenariopsis* and MacGillivray's species is therefore renamed here. MacGillivray gave no locality for his specimen, which consisted of two fragments only. As mentioned by Powell (1966) the specimens are labelled 'Muddy Creek'. MacGillivray considered that the basal rhizoid window and porous area was the zooid orifice, and that the orifices on the other side of the fragments were 'probably avicularian'. Without the advantage of having complete colonies for examination, the basal and frontal surfaces do look remarkably alike. Both have smooth

calcification marked into rectangles by vertical zooid walls. The more oval basal windows and slightly worn orifices appear to be extremely similar, to superficial inspection, and it is easy to understand how MacGillivray made the wrong interpretation.

The specimens examined here are also all fragmentary, and are generally rare, although present at a large number of localities. More than 70 fragments, the largest of more than 50 zooids, are present in the sample from Princetown, and are accompanied by *S. marginata* sp. nov.

S. macgillivrayi differs from *S. gabrieli* in the more elongated shape of the orifice, and the slightly smaller and rounder basal porous areas. The principal difference is that the zooid distal to the ovicell is an autozooid, not a kenozooid, and the entooecial areas are placed close to the median suture, on the frontal surface of the ovicell. *S. macgillivrayi* differs from *S. marginata* sp. nov. in the size of zooids, and the shape and size of zooid orifices. The basal porous areas are larger and the basal windows narrower.

Selenariopsis marginata sp. nov. (Figs 3, 4, 6, 9, 10)

Material Examined

Holotype: MV P140966, Princetown, Miocene.

Paratype material: Princetown and Balcombe Bay, Victoria, Miocene (SAM P35471).

Description

Autozooid frontal shields large, short and wide, often almost square. Orifices nearly central, large, marginally raised, elongated, with a subtriangular sinus and minute lateral embayments only visible in well preserved specimens. The brooding zooid orifice is wide and rounded with a subtriangular sinus. The ovicell is more prominent than that of *S. macgillivrayi*, and distinctly narrower than both the brooding zooid and distal autozooid. The frontal areas are often not obvious, but when present, are placed well away from the median suture on the ovicell frontal wall. The basal windows of autozooids and brooding zooids are oval or nearly circular. The basal rhizoid windows are usually small, and are sometimes more subtriangular than crescentic; the porous area is also very small, sometimes minute, and is circular, with a raised rim and scattered pores.

Etymology

Marginatus. L., enclosed with a border, referring to the raised rims of the zooidal orifices.



Distribution

Miocene of Victoria.

Remarks

S. marginata is represented by fewer than 60 fragments, the largest of only 8 zooids, but its characters are distinct and consistent. The dimensions of zooids appear to be generally much larger than those of the other two species, at the inferred equivalent astogenetic stage.

S. marginata is distinguished from both *S. gabrieli* and *S. macgillivrayi*, with which last it often occurs, by the raised margins of the elongated orifices. These may be so prominent that they make the colony surface appear to be rugose. The other obvious difference is the small size of the basal porous areas. The ovicell is less depressed than that of *S. macgillivrayi*, which it resembles in having a distal autozooid, unlike the kenozooid of *S. gabrieli*.

DISCUSSION

Although no complete colony of *Selenariopsis* has been preserved as a fossil, it is remarkable that such delicate species have been found in fragments large enough to be recognizable, and distinguishable from each other. The slight curvature and the budding pattern of the fragments allow the inference that they had a lunulitiform shape when complete. The occurrence of the distinctive windows and porous areas on the basal side of the fossils allows the inference that they, too, developed rhizoids in life, and lived in a similar manner to *S. gabrieli*. The larger fragments of *S. macgillivrayi* show ridges frontally between zooid generations and 'growth lines' in the calcification of the frontal shields (Fig. 5). These also occur in colonies of *S. gabrieli*, where they appear to be related to episodes of repair, and of 'seasonal growth', and to rapid calcification of the frontal membranous wall of zooid buds (Fig. 1).

The differences among the three species of *Selenariopsis* are small, but in several characters, the states are distinct and consistently correlated

(Table 1). *S. gabrieli* resembles *S. macgillivrayi* in many ways and may be a direct descendant. *S. marginata* differs from both species in zooid size and the raised margins of the elongated autozooid orifices, as well as in the very small basal porous areas.

It is interesting that the Recent species, *S. gabrieli*, exhibits two features which indicate a closer relationship with the genus *Eurystomella* than with its fossil congeners. The cryptocyst embayments at the edge of the orifice, although small in *S. gabrieli*, are distinct; in the fossil species they are much smaller, and can often hardly be distinguished. Further, in *S. gabrieli* and all species of *Eurystomella*, the kenozooid which completely envelops the distal end of the ovicell capsule also bears the entoecial window or fenestrae on its frontal wall.

In *S. macgillivrayi* and *S. marginata* the entoecial areas are part of the frontal wall of the ovicell capsule, not the distal autozooid, which surrounds the capsule on the basal side only. A

TABLE 1. Measurements in mm of species of *Selenariopsis*. Lz, lz, length and width of autozooid; Lo, lo, length and width of orifice; L bro, l bro, length and width of brooding zooid orifice; Lov, lov, length and width of ovicell; Lbw, lbw, length and width of basal window; Lrw, lrw, length and width of rhizoid window; Lpa, lpa, length and width of porous area.

Character	<i>S. gabrieli</i>	<i>S. macgillivrayi</i>	<i>S. marginata</i>
Lz	0.30–0.44	0.30–0.45	0.37–0.66
lz	0.25–0.40	0.25–0.40	0.36–0.48
Lo	0.11–0.16	0.13–0.18	0.18–0.25
lo	0.10–0.12	0.10–0.13	0.12–0.16
L bro	0.11–0.13	0.16–0.18	0.15–0.17
l bro	0.16–0.18	0.16–0.19	0.14–0.16
Lov	0.08–0.10	0.18–0.23	0.25–0.30
lov	0.21–0.24	0.22–0.32	0.30–0.40
Lbw	0.16–0.22	0.20–0.21	0.17–0.24
lbw	0.12–0.15	0.02–0.06	0.12–0.14
Lrw	0.10–0.12	0.08–0.09	0.08–0.10
lrw	0.20–0.23	0.14–0.18	0.10–0.16
Lpa	0.18–0.25	0.20–0.25	0.08–0.16
lpa	0.16–0.25	0.17–0.25	0.08–0.18

FIGURES 7–10. 7, *Selenariopsis gabrieli* Maplestone, Kimbla Stn 99. Basal walls, showing uncalcified windows of brooding zooids and ovicells (b), autozooids (a), and one rhizoid window (r). Large, subrectangular porous area with marginal pores (p), X100; 8, *S. macgillivrayi* sp.nov., Princetown. Narrow basal windows of autozooids and one rhizoid window with proximal porous area (p), X80; 9–10, *S. marginata* sp.nov., Princetown. Distal autozooid, and proximal rhizoid basal windows; note small, circular porous areas (p). Fig. 9, X80; Fig. 10, X100.

parallel series of differing relationships in time, among the brooding zooids, ovicells and distal zooids occurs in species of the Australian Tertiary-to-Recent genus *Quadriscutella* (see Bock & Cook 1993).

The cuticle-covered basal window of each zooid of *Selenariopsis* has a parallel in the ascophoran genera *Chiastosella* and *Didymosella*. Both these genera have a wide Tertiary-to-Recent geographic range, and are particularly well represented in Australasia. Although many species have a semi-repent, unilaminar colony form, none is lunulitiform. Powell (1967:285) noted that colonies of *Chiastosella splendida* were attached by basal rhizoids, but the only description of the basal windows was given by Waters (1881:340) in fossil specimens of *C. conservata* from Victoria. The basal windows of *Didymosella larvalis* were described by Cook and Chimonides (1981b); they do not give rise to any rhizoids, but in *D. pluma*, a South American species, they may be produced into long, hollow, extrazoidal calcified processes.

Many of the reports of *S. gabrieli* have been from fairly deep shelf, and upper slope depths, the two deepest among the samples listed above being from 520 and 800 m. The associated bryozoans from these samples include many with cellulariiform, erect colonies, all anchored by rhizoids (see Bock & Cook in press). Species found in association with *S. gabrieli* at the shallower end of the depth range have been discussed by Cook (1979), and included forms of *Melicerita*, *Sphaeropora* and *Conescharrellina*. These too, are anchored by rhizoids. Specimens of these three genera are robust, and are often preserved entire as fossils as well as occurring in Recent sediments. Some colonies of *Conescharrellina*, and of the free-living lunulitiform genera *Lunulites*, *Lunularia* and *Selenaria* all occur in the Princetown samples. There is, however, no correlation of numerous sand fauna taxa in association with the two fossil species of *Selenariopsis*, and certainly no suggestion that the assemblage was from very deep water.

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We should like to thank the Museum of Victoria and Australian Museum for access to collections, and D. McDonald for help in preparation of this paper.

APPENDIX

Details of Tertiary Localities in Victoria and South Australia.

Balcombe Bay: Also known as **Fossil Beach, Mornington, Mount Martha** and possibly **'Schnapper Point'** (MacGillivray); on coast of Port Phillip Bay, about 3 km south of Mornington, Victoria. Lat. 38°14.5'S, Long. 145°01.7'E. Fyansford Clay. Age: Balcombian; Middle Miocene, (Langhian).

Cooriemungle area: Road cuttings about 18 km north of Princetown. Lat. 38°32.4'S, Long. 143°08.1'E. Gellibrand Marl. Age: Balcombian.

Gellibrand. This locality was mentioned by MacGillivray (1895), and is in the same area as **Princetown** (see below).

Grices Creek: Also known as **Gunyong Creek**; on coast of Port Phillip Bay, about 8 km north of Mornington, Victoria. Lat. 38°11.9'S, Long. 145°03.9'E. Fyansford Clay. Age: Balcombian (some material may be Bairnsdalian); Middle Miocene, (Langhian).

Mount Schanck: Limestone quarry about 1 km west of Mount Schanck, about 15 km south of Mount Gambier, South Australia. Lat. 37°57'S, Long. 140°43.2'E. Gambier Limestone. Age: Longfordian; Early Miocene.

Muddy Creek: Clifton Bank, Muddy Creek, 8 km west of Hamilton, Victoria. Lat. 37°44.6'S, Long. 141°56.4'E, Muddy Creek Marl (= Gellibrand Marl). Age: Balcombian.

Princetown (*Gigantocypraea* locality): Coastal section, about 2 km west of Princetown, Victoria. Lat. 38°41.9'S, Long. 143°08.3'E, Gellibrand Marl. Age: Balcombian.

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**COELOPLANA SCABERIAE SP. NOV., A NEW BENTHIC CTENOPHORE
(CTENOPHORA: PLATYCTENIDA: COELOPLANIDAE) FROM SOUTH
AUSTRALIA**

G. I. MATSUMOTO & K. L. GOWLETT-HOLMES

Summary

A new species of benthic ctenophore, *Coeloplana scaberiae* sp. nov., is described from South Australia, and some preliminary observations on the behaviour and abundance of this new species are presented. The new species can be distinguished from other species in the genus by its bright red or orange colour and its specific host plant, the brown alga *Scaberia agardhii* Greville. This is the fourth record of benthic ctenophores from Australia.

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MATSUMOTO, G. I. & GOWLETT-HOLMES, K. L. 1996. *Coeloplana scaberiae* sp. nov., a new benthic ctenophore (Ctenophora: Platyctenida: Coeloplanidae) from South Australia. *Records of the South Australian Museum* 29(1): 33–40.

A new species of benthic ctenophore, *Coeloplana scaberiae* sp. nov., is described from South Australia, and some preliminary observations on the behaviour and abundance of this new species are presented. The new species can be distinguished from other species in the genus by its bright red or orange colour and its specific host plant, the brown alga *Scaberia agardhii* Greville. This is the fourth record of benthic ctenophores from Australia.

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Members of the Phylum Ctenophora have the potential to impact ecosystems to a considerable extent (Carlton & Geller 1993), yet research on this group has been relatively sparse because of the difficulties in collecting specimens. Within this phylum there are currently seven orders, one of which (Platyctenida) are benthic in habit. There are four families within this order and approximately 40 species. The platyctenes are unusual in that they are benthic, they have lost (secondarily) the characteristic ctene rows, and are capable of both sexual and asexual reproduction (Harbison & Madin 1982). Their ability to reproduce both sexually and asexually is unique among the ctenophore phylum and can often result in extremely high densities. A species of platyctene in Hawai'i reaches densities of over 3000 individuals/square meter (C. P. Galt, pers. comm.). Platyctenes range in distribution from tropical (Arnold 1993) to polar (Dayton & Robilliard 1972) waters, and can be found living on various hosts, including ascidians, hydroids, asteroids, echinoids, and algae. Many species of platyctenes look similar to platyhelminths when preserved and may be found in collections labelled as such.

There are only three previous records of platyctenes from Australian waters (Stephenson *et al.* 1931, Smith & Plant 1976, Arnold 1993). Stephenson *et al.* (1931) describe the presence of *Coeloplana* sp. on the Great Barrier Reef but give no specific identification. Smith and Plant (1976)

describe specimens (Museum of Victoria, G2649) tentatively identified as *Coeloplana willeyi* collected from 15.5 m depth with green algae (*Caulerpa* sp) and unidentified red algae at the southern end of Port Phillip Bay, Victoria. Arnold (1993) collected specimens (Queensland Museum, G35888) of *Coeloplana meteoris* from Pioneer Bay, Orpheus Island from soft substrate at 12–13 m depth. W. M. Hamner collected specimens of planktonic transparent *Ctenoplana* off of Townsville but has not published these observations (pers. comm.).

Recently, some strikingly coloured animals living in association with the brown alga *Scaberia agardhii* Greville, 1830, previously thought to be platyhelminths, have been identified as an undescribed species of platyctene. This paper presents a description and some preliminary observations on the behaviour and abundance of this new species. This new species is confined to small populations on *Scaberia agardhii* in the shallow subtidal. As *Scaberia agardhii* is endemic to southern Australia we postulate that the new species of platyctene is also likely to be endemic to this region. Further work on this species and related species is in progress.

MATERIALS AND METHODS

The material reported here is deposited in the South Australian Museum, Adelaide (SAM), the

Australian Museum, Sydney (AM), the Museum of Victoria, Melbourne (MV), the Queensland Museum, Brisbane (QM), the Western Australian Museum, Perth (WAM), and the California Academy of Sciences, San Francisco (CAS). All material was fixed and preserved in 2% formaldehyde/propylene glycol solution in sea water, with the exception of one lot (SAM XH0010), which was fixed and preserved in 70% alcohol for later DNA extraction.

The ctenophores were first observed in the field using SCUBA equipment. Photographs were taken in the field with Nikonos III cameras with UW Nikkor 28 mm and UW Nikkor 35 mm lenses, Sea & Sea extension tubes, and Ikelite strobes, and in the laboratory with a Nikon F2 with a Nikkor 55 mm macro lens and strobes. Living specimens were collected by hand and transported back to the laboratory in aerated containers. Fragments of the host alga, *Scaberia agardhii*, were also collected and transported with the ectocommensal ctenophores intact. Colour transparencies (Photo index PH0141–4, PH0184) of the in situ specimens are held in the Photoindex collection of the Marine Invertebrates Section of SAM. Colour description of the new species follows Kornerup and Wanscher (1978).

Specimens used for examination under the scanning electron microscope (SEM) were dehydrated (in a sequential ethanol series) to 100% ethanol, critical point dried, and coated with gold. They were photographed using a Cambridge Mark III SEM.

SYSTEMATICS

Order Platyctenida Mortensen, 1912

Diagnosis

Body with a pair of conspicuous tentacles; body solid, greatly compressed in the oral/aboral axis, oral portion everted to form a creeping sole. Ctenes usually greatly reduced or absent in adults. Many species are ectocommensals.

Family COELOPLANIDAE Willey, 1896

Diagnosis

Creeping or sessile ctenophores, ctenes absent in adults. Tentacles, with tentilla, retractable into sheaths. Meridional canals branched and anastomosed. Pharynx permanently everted; statocyst present and aboral; body length < 6 cm.

Genus *Coeloplana* Kowalevsky, 1880

Diagnosis

With the features of the family.

Remarks

In addition to the new species described below, there are 22 other species of *Coeloplana* described between 1880 and 1970, some of which have been well documented (e.g. *C. willeyi*) and others of which are known only from fragments (e.g. *C. bannwarthi*). The majority of the described species are host-specific and have distinctive colours and patterns.

Coeloplana scaberiae sp. nov.

(Figs 1–3)

Material Examined

Holotype. SAM H843 (PH0143), found on the brown alga *Scaberia agardhii*, in 3–4 m depth, Edithburgh, Yorke Peninsula, Gulf St. Vincent, South Australia (35°5'S, 137°41'E), collected by K. L. Gowlett-Holmes 7 January 1994.

Paratypes. SAM H844 (PH0143) (19), AM G15606(2), MV F75050 (2), QM G305828 (2), CASIZ 104015(2), all same collection data as holotype; SAM H845 (PH0184) (2), same collection data as holotype except for date, 12 June 1994; SAM H846 (PH0141) (18), same collection data as holotype except for water depth, 4–5 m, and date, 3 January 1992; SAM H847 (PH0142) (15), WAM 3–95 (2), same collection data as holotype except for date, 18 May 1992; SAM H848 (PH0144) (85 + fragments), from on the brown alga *Scaberia agardhii*, in 3–4 m depth, Point Turton Jetty, Yorke Peninsula, Spencer Gulf, South Australia, collected by K. L. Gowlett-Holmes 2 April 1994.

Other material. SAM XH0010, same collection data as holotype, alcohol-fixed specimens.

Description

The following description is based on field and laboratory observations of both living and preserved specimens.

Platyctenes to at least 25 mm in length; solid dark orange or vivid red in colour without spots of any kind. Individuals have four rows of papillae extending from the aboral organ in a figure eight pattern, also papillae along the margin (Fig. 1A); papillae appear glandular (Fig. 2) and are capable of extending or retracting so that they are indistinguishable from the aboral surface,

particularly with preserved specimens. With two tentacles, both with tentilla (Fig. 1A); oral groove present (Fig. 1B). Temporary chimneys may be formed by a bending upwards of the oral groove, with the tentacle emerging from the center of the chimney. Embryos present along the margins of some specimens, both preserved and live. Meridional canal structure has not yet been

determined due to the opaque nature of the ctenophore body. Tentacular sheath morphology is highly variable ranging from anchor shaped (Fig. 1A) to \pm shaped. This extra cross piece in the tentacle sheath is similar to that found in *Vallicula* Rankin, 1956, but the tentacles have not been observed coiled within the cross piece (as in *Vallicula*).

Habitat

Found only on the brown alga *Scaberia agardhii* Greville, 1830, in colonies containing a single colour morph (red or orange) (Figs. 3, 4), usually on the tips of the plant. Very few *S. agardhii* are colonised, but when the ctenophores are present, they are abundant (from one to 50 per alga) and can be found on one or more branches, but rarely the whole plant. *C. scaberieae* is the first species of *Coeloplana* known to have an obligate association with a brown algal host.

Distribution

Central South Australia. Currently known only from the type localities, but has also been reported



FIGURE 1. *Coeloplana scaberieae* sp. nov. Paratype SAM H844. Camera lucida sketches of aboral (A) and oral (B) surfaces. Note the presence of papillae (P) on the aboral side and the oral groove (og) on the oral side. The tentacles (T) have tentilla (t) that originate along one side of the tentacle. The tentacle sheath is large and has a cross bar (c) that can vary in shape and size. Scale bars = 1 mm.

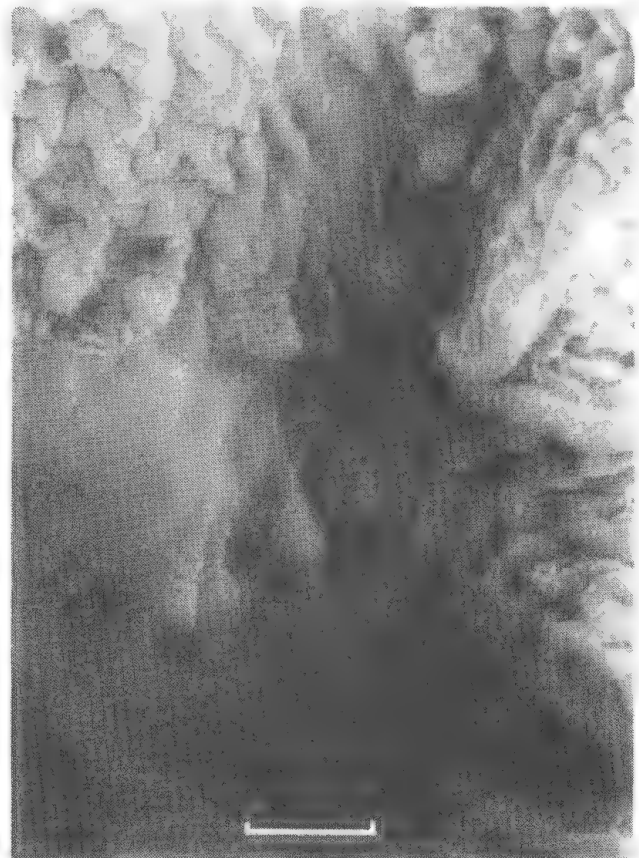


FIGURE 2. *Coeloplana scaberieae* sp. nov. SEM of the aboral surface showing the aboral papillae (P) and rugose structure of the aboral surface. This is characteristic of preserved specimens; live specimens often have a smooth surface when fully extended. Scale bar = 400 μ m.

from Victor Harbour, Encounter Bay, Fleurieu Peninsula, SA. Given the abundance of *Scaberia agardhii* in other areas of South Australia, further investigations should reveal the presence of *Coeloplana scaberieae* in these areas. *Scaberia agardhii* is endemic to southern Australia and it is likely that *C. scaberieae* is also endemic to this region.

Etymology

The species name *scaberieae* is derived from the generic name of its host alga *Scaberia*, in recognition of the specific association between the two species. Both names are based on the Latin *scaber* which is defined as rough, scabby, or mangy (Brown 1956), which describes both the ctenophore and its host alga.



FIGURE 3. *Coeloplana scaberieae* sp. nov. Paratypes SAM H846 (PH0141). In situ photograph showing ctenophores on the host alga *Scaberia agardhii*. There is a white sponge (s) that is always present and whose role in this commensal relationship is unknown. Scale bar = 0.5 cm.



FIGURE 4. *Coeloplana scaberieae* sp. nov. In situ photograph showing ctenophore (ct) with tentacles extended in a typical fishing posture, on the host alga *Scaberia agardhii*. Scale bar = 0.5 cm.

Behaviour

The ctenophores feed at night and can be induced to feed in the laboratory in darkness. This suggests that there is not a circadian type of rhythm influencing the feeding bouts. White light in the form of a flashlight, strobe, or room light quickly causes these animals to withdraw their feeding tentacles and cease feeding despite a high food abundance. The animals will feed and can be observed under red light, and have been kept in the laboratory for three weeks without any noticeable deterioration. The host alga *Scaberia agardhii* however tends to die after three weeks and the ctenophores have been difficult to transplant to another substrate. The ctenophores require a high flow rate and are very susceptible to infection from ciliates. Specimens in the laboratory were fed enriched *Artemia salina* nauplii and did well until the host plant died. This high specificity suggests that the association is a very restricted one. An unidentified white sponge has always been observed under the ctenophore and it is possible that the sponge is providing a food source or is the host rather than *Scaberia*.

The mode of reproduction in this species is not clear yet, but embryos have been found under the margin on 18 of 22 preserved specimens. Other species in this genus are thought to have brood pouches in the aboral papillae (Harbison & Madin 1982). Dissections of aboral papillae showed no signs of embryos or use of papillae as brood chambers. The papillae are hollow within and open directly into the gastrovascular cavity. Embryos are found under the ventral margin of preserved ctenophores, particularly within the folds of the margin. It is possible that the embryos are brooded within the papillae and are released through the oral opening when the ctenophores are stressed (i.e. placed into preservative). In addition to the brooded embryos, the ctenophores were observed to reproduce by fragmentation in the laboratory. This mode of asexual reproduction is unique to this order.

DISCUSSION

The host specificity of most of the *Coeloplana* species and the bright and distinctive colouration are useful taxonomic characteristics. Some of the earlier descriptions are lacking in detail or in specimens (*C. metschnikowii* or *C. bannwarthi*), and the classification of the group may require revision when further material of these is discovered. A key is provided below for all of the

known species in the genus. Descriptions are taken from the original literature except for *C. meteoris* (information from Arnold 1993).

KEY TO THE KNOWN SPECIES OF *COELOPLANA*.

- 1 – Host is an animal or plant 2
 - Host unknown; or ctenophores found on sediment or in plankton 22
- 2 – Host is algae or seagrass 3
 - Host is an animal 8
- 3 – Epiphytic on seagrass 4
 - Epiphytic on algae 6
- 4 – Epiphytic on *Zostera* 5
 - Epiphytic on *Posidonia*, ctenophore colour deep olive green with sepia spots, tentacles yellow brown with a narrow yellow orange margin
..... *Coeloplana perrieri* Dawydoff, 1930
- 5 – Ctenophore colour grey (dorsal) and white (ventral) (colour possibly a fixation artefact)
..... *Coeloplana metschnikowii* Kowalevsky, 1880
 - Host association not specific (originally described from “red *Zostera*” – possibly host plant was misidentified). Ctenophore colour deep purple, red or orange fading to pink with white spots along the margin and yellow blotches at the base of papillae
..... *Coeloplana willeyi* Abbott, 1907
- 6 – Obligate epiphyte on the brown alga *Scaberia agardhii*
..... *Coeloplana scaberae* sp. nov.
 - Epiphytic on algae other than *Scaberia agardhii* 7
- 7 – Epiphytic on red algae (e.g. *Melobesia* sp.) or brown algae (e.g. *Sargassum*), ctenophore colour brown to brownish yellow or chocolate brown with yellow white cells around the margin and two bands of yellow around the statocyst; 10–20 aboral papillae each with 2–5 digitate processes
..... *Coeloplana mitsukurii* Abbott, 1902
 - Host association not specific. Epiphytic on *Caulerpa*, red algae, coralline algae, *Sargassum*. Ctenophore colour deep purple, red or orange fading to pink with white spots along the margin and yellow blotches at the

- base of papillae
..... *Coeloplana willeyi* Abbott, 1907
- 8 – Epizooic on echinoderm 9
– Epizooic on cnidarian 14
- 9 – Epizooic on echinoid 10
– Epizooic on asteroid 13
- 10 – Epizooic on *Diadema*, ctenophore colour solid dark purple matching host, known only from a fragmented specimen
.. *Coeloplana bannwarthi* Krumbach, 1933
– Epizooic on echinoid other than *Diadema*, ctenophore colour does not match host ... 11
- 11 – Epizooic on *Toxopneustes*, ctenophore colour yellow brown with a wide pale green margin
..... *Coeloplana echincola* Tanaka, 1931
– Epizooic on echinoid other than *Toxopneustes*, ctenophore colour not as above 12
- 12 – Epizooic on *Heterocentrotus mammillatus*, ctenophore colour brownish red, distinctive in lacking papillae
..... *Coeloplana weilli* Dawydoff, 1938a
– Host association not specific. Epizooic on *Heterocentrotus mammillatus*, *Echinothrix diadema*. Ctenophore colour deep purple, red or orange fading to pink with white spots along the margin and yellow blotches at the base of papillae
..... *Coeloplana willeyi* Abbott, 1907
- 13 – Epizooic on *Echinaster luzonicus* (Asteroidea), ctenophore colour mottled brownish red to brownish violet and white .
.... *Coeloplana astericola* Mortenson, 1927
– Epizooic on *Pentaceros hedemanii* (Oreasteriidae), ctenophore colour unknown; 6–20 papillae
Coeloplana krusadiensis Devanesan & Varadarajan, 1942
- 14 – Epizooic on gorgonian or alcyonacean 15
– Epizooic on pennatulid *Pteroeides*, ctenophore colour intense orange or vermilion to orange; distinctive in lacking papillae
..... *Coeloplana dubosqui* Dawydoff, 1930
- 15 – Epizooic on gorgonian *Solenocaulon*, ctenophore colour brick red with white spots; oral groove present
..... *Coeloplana sophiae* Dawydoff, 1938b
- Epizooic on alcyonacean 16
- 16 – Epizooic on *Dendronephthys*, ctenophore colour dark vermilion, dark red, brick red, pink, orange, or grey stripes branching and anastomosing
..... *Coeloplana bocki* Komai, 1920
– Not epizooic on *Dendronephthys* 17
- 17 – Epizooic on *Cladiella* or *Alcyonium* 18
– Epizooic on *Sarcophyta* 20
- 18 – Epizooic on *Cladiella* or *Alcyonium*, ctenophore colour pink (in situ) or milky white (after preservation in formalin) with yellow tentacle bases and 4–5 pairs of papillae*Coeloplana komai* Utinomi, 1963
– Epizooic on *Alcyonium*, ctenophore colour and form not as above 19
- 19 – Ctenophore colour is milky white with brown spots; 14 papillae in two distinct rows
..... *Coeloplana gonoctena* Krempff, 1921
– Ctenophore colour clear, milky white, or violet brown; 6–16 papillae
..... *Coeloplana agniae* Dawydoff, 1930
- 20 – Ctenophore colour unknown; 40 papillae ...
.... *Coeloplana wuennenbergi* Fricke, 1970
– Ctenophore colour unknown; more than 40 papillae 21
- 21 – Ctenophore colour unknown; 70–100 papillae...*Coeloplana punctata* Fricke, 1970
– Ctenophore colour unknown; 60–70 papillae
..... *Coeloplana lineolata* Fricke, 1970
- 22 – Habitat known 23
– Host or habitat unknown, ctenophore colour unknown
..... *Coeloplana indica* Devansan & Varadarajan, 1942
- 23 – Ctenophore planktonic 24
– Ctenophore benthic in soft sediments; ctenophore colour clear with yellow white reticulations covering body and red pigmentation around canals, tentacle sheaths and papillae
..... *Coeloplana meteoris* Thiel, 1968
- 24 – Ctenophore colour is perfectly transparent pale green, with 7–8 aboral papillae, 32 orange papillae arranged in 8 rows
..... *Coeloplana mesnili* Dawydoff, 1938b

- Ctenophore colour transparent green; 8 papillae
..... *Coeloplana tatersalli* Devansan & Varadarajan, 1942

From the above key and our observations, it is clear that the ctenophores discovered in South Australia are a distinct species. *C. scaberiae* is one of three *Coeloplana* species found on brown algae and it is the only obligate commensal species (*C. willeyi* and *C. mitsukurii* can be found on *Sargassum*, but are also found on other substrates). *C. scaberiae* possesses an oral groove as does *C. sophiae* but lacks the white spots found on *C. sophiae* and *C. willeyi*. The presence of an oral groove and an extra cross piece in the tentacle sheath are diagnostic characters for the genus *Vallicula*. The presence of a permanent chimney formed from the oral groove is characteristic of the genus *Lyrocteis* Komai, 1941. *C. scaberiae* has an oral groove, can form temporary chimneys, and may exhibit the cross pieces in the tentacular

sheath. These observations suggest that the designation of *Vallicula* and *Lyrocteis* in a separate family (Lyrocteisidae) may need to be reconsidered. *C. scaberiae* is found with either red or orange colouration which is similar to the colouration of *C. willeyi*, but *C. willeyi* also has white spots along the margin and yellow spots at the base of the papillae that *C. scaberiae* lacks. Body colouration and host specificity clearly separate this new species from all of the described species. A molecular analysis of this group and the Phylum Ctenophora generally is in progress by one of the authors (GIM).

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SUBFOSSIL EVIDENCE OF STRANDINGS OF THE SPERM WHALE PHYSTER MACROCEPHALUS IN GULF ST VINCENT, SOUTH AUSTRALIA

C. M. KEMPER, N. KEMPER & J. K. LING

Summary

Sperm whale *Physeter macrocephalus* bones and teeth found in Holocene sands along the eastern side of Gulf St Vincent have been studied and dated by comparative stratigraphy or carbon-dating of sediments in which they lay. Three skulls, two from just north of Parham and one from Port Gawler, were found 0.7 and 1.0 km inland from the modern coastline. They were in coastal sediments about 2000 years old. Other bones of *P. macrocephalus* found in various situations along Adelaide beaches could not be accurately dated because they were found in or on unstable sands. At least six animals were represented in the available material. Five (three males, two unsexed) were 8-12 m long and the other (a male) was about 14 m long. The specimens are the only records of sperm whales in Gulf St Vincent and may represent a two thousand year old mass stranding of bachelor males.

SUBFOSSIL EVIDENCE OF STRANDINGS OF THE SPERM WHALE *PHYSETER MACROCEPHALUS* IN GULF ST VINCENT, SOUTH AUSTRALIA

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C. M. KEMPER, N. PLEDGE and J. K. LING. 1996. Subfossil evidence of strandings of the sperm whale *Physeter macrocephalus* in Gulf St Vincent, South Australia. *Records of the South Australian Museum* 29(1): 41–53.

Sperm whale *Physeter macrocephalus* bones and teeth found in Holocene sands along the eastern side of Gulf St Vincent have been studied and dated by comparative stratigraphy or carbon-dating of sediments in which they lay. Three skulls, two from just north of Parham and one from Port Gawler, were found 0.7 and 1.0 km inland from the modern coastline. They were in coastal sediments about 2000 years old. Other bones of *P. macrocephalus* found in various situations along Adelaide beaches could not be accurately dated because they were found in or on unstable sands. At least six animals were represented in the available material. Five (three males, two unsexed) were 8–12 m long and the other (a male) was about 14 m long. The specimens are the only records of sperm whales in Gulf St Vincent and may represent a two thousand year old mass stranding of bachelor males.

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Whale bones are occasionally uncovered from coastal sediments around Australia. Dixon (1990) reported on the skeletal remains of a southern right whale *Eubalaena australis* from Port Phillip Bay, Victoria. She suggested that the bones came from whales caught during nineteenth century whaling operations in the region. In South Australia many whale bones are found in the vicinity of nineteenth century whaling stations (Kostoglou & McCarthy 1991). The bones are usually identified as *E. australis* (C. Kemper, unpublished data), the principal species hunted from shore stations. The skeleton of a humpback whale *Megaptera novaeangliae*, probably deposited in the last few hundred years by a storm, was found buried on Moreton Island, Queensland (Bushing 1991).

The South Australian Museum holds several cetacean specimens of unknown age from Gulf St Vincent and Spencer Gulf. These include a blue whale *Balaenoptera musculus* part skull and skeleton recovered from sediments in mangroves near Whyalla and a part skull from shifting sand dunes near Cowell. Two bullae from a *M. novaeangliae* were donated by the Silicate Brick Company, Largs Bay and were presumably found in Holocene or Pleistocene deposits there. A partial rib of *E. australis* was found in shell grit at about 2 m depth while excavating for the

foundations of the power station on Torrens Island, near Adelaide. Torrens Island sediments are believed to be less than 4000 years old (A. Belperio, pers. comm.). A lumbar vertebra, possibly of *E. australis*, was found in 2 m of sediments in the early Holocene Lipson Formation (Firman 1966), 1 km inland at West Lakes in suburban Adelaide.

Obtaining accurate carbon-dates for subfossil cetacean bones is difficult because all marine organisms are affected by the depletion of ¹⁴C (relative to terrestrial wood, the standard for carbon-dating) in the marine environment. This is known as the 'reservoir effect' and it is greatest in the Antarctic and subAntarctic seas (Omoto 1983). Gordon & Harkness (1992) reviewed data for vertebrates and invertebrates in the Antarctic region and concluded that for whale bones a minimum correction factor of 1000 years may apply. For that reason, Bushing (1991) concluded that the geological age of the *M. novaeangliae* skeleton found on Morton Island, Queensland, dated at 1410 ± 70 years, was not subfossil. Radio-carbon dates for subfossil north Atlantic gray whales *Eschrichtius robustus* have been more informative (Bryant 1995) because the reservoir effect there is not as great, ranging from 365 to 750 years (Gordon & Harkness 1992), and because the subfossils that Bryant was studying were up to 8330 years old.

This study reports on three subfossil sperm whale *Physeter macrocephalus* skulls found in

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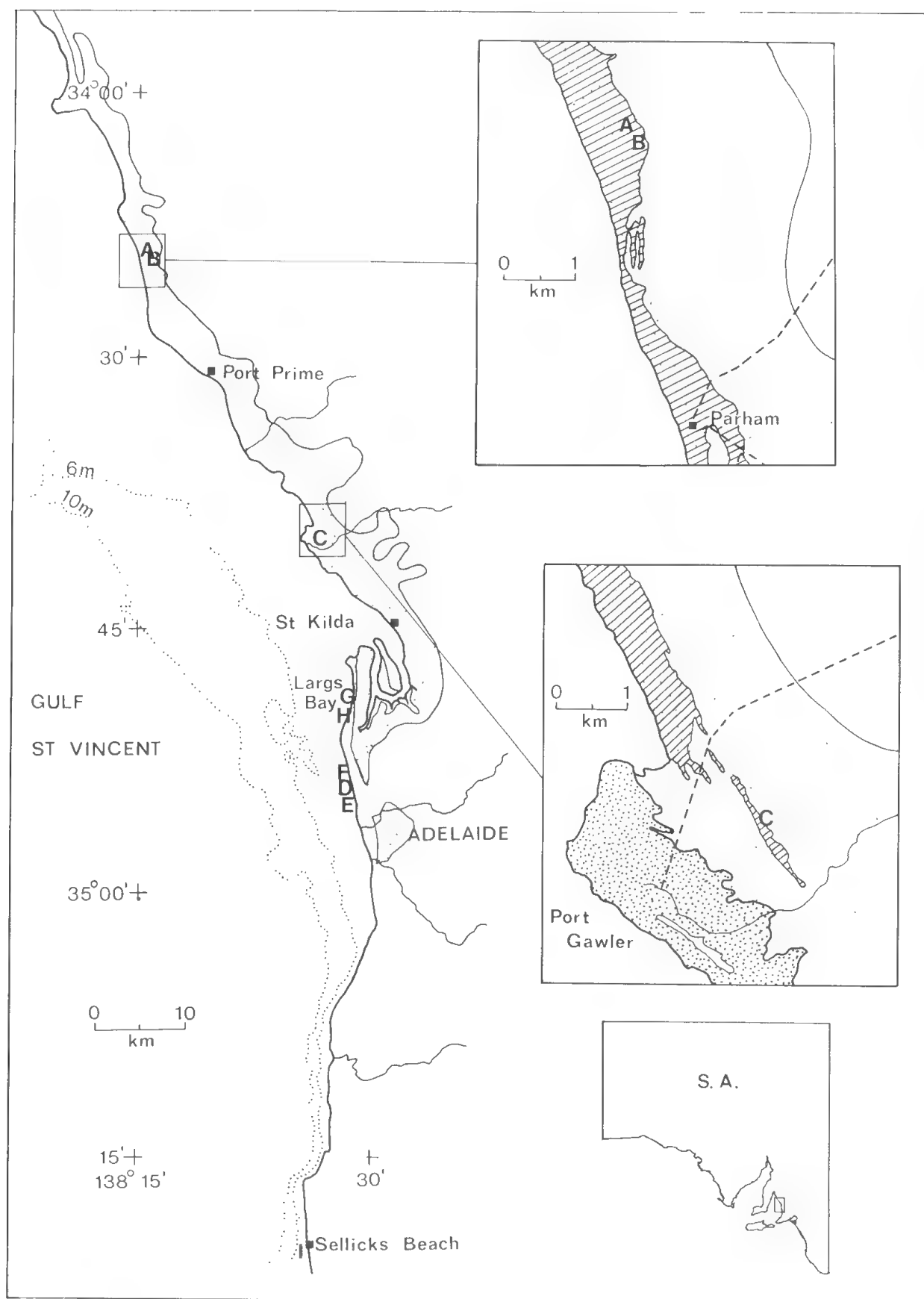


FIGURE 1. Location of sites where sperm whale skeletal material has been found along eastern side of Gulf St Vincent. ■ towns, - - - major roads, stippled mangroves, dotted Holocene sands, hatched beach ridges, water depth contours.

TABLE 1. Sperm whale skeletal material collected along the eastern coast of Gulf St Vincent, SA. Rel. = reliability of identification (see results). Reg. No. = P, Palaeontology, M, Mammalogy collections at the South Australian Museum. Date = date collected. GPO = general post office.

Spec.	Rel.	Material	Reg. No.	Date	Locality	Site
A	1	cranium, mandible, teeth, vertebra	P31428	1989	4 km N Parham	buried 1-2 m in shell grit, 700 m inland
B	1	part-cranium	—	1989	4 km N Parham	buried 1-2 m in shell grit, 700 m inland
C	1	cranium	—	1991	2 km NE Port Gawler	buried 1 m in shell grit, 1 km inland
D	2	caudal vertebra	M18064	<1960	Tennyson/North Grange	unknown
E	1	part-cranium, R mandible, caudal vertebra	M14434	1987	Tennyson, 10 km WNW Adelaide (GPO)	in sand, under 1.5 m water, well below low tide mark
F	3	part-cranium	M14435	1986	Tennyson, 12 km NW Adelaide (GPO)	on sandbar, after storm
G	1	part R mandible	M18059	1992	Largs Bay	foredunes?
H	1	L humerus	—	1993	Largs Bay	in seaweed, at high tide mark
I	3	2 parts cranium	M18061	1994	Sellicks Beach	found while dredging

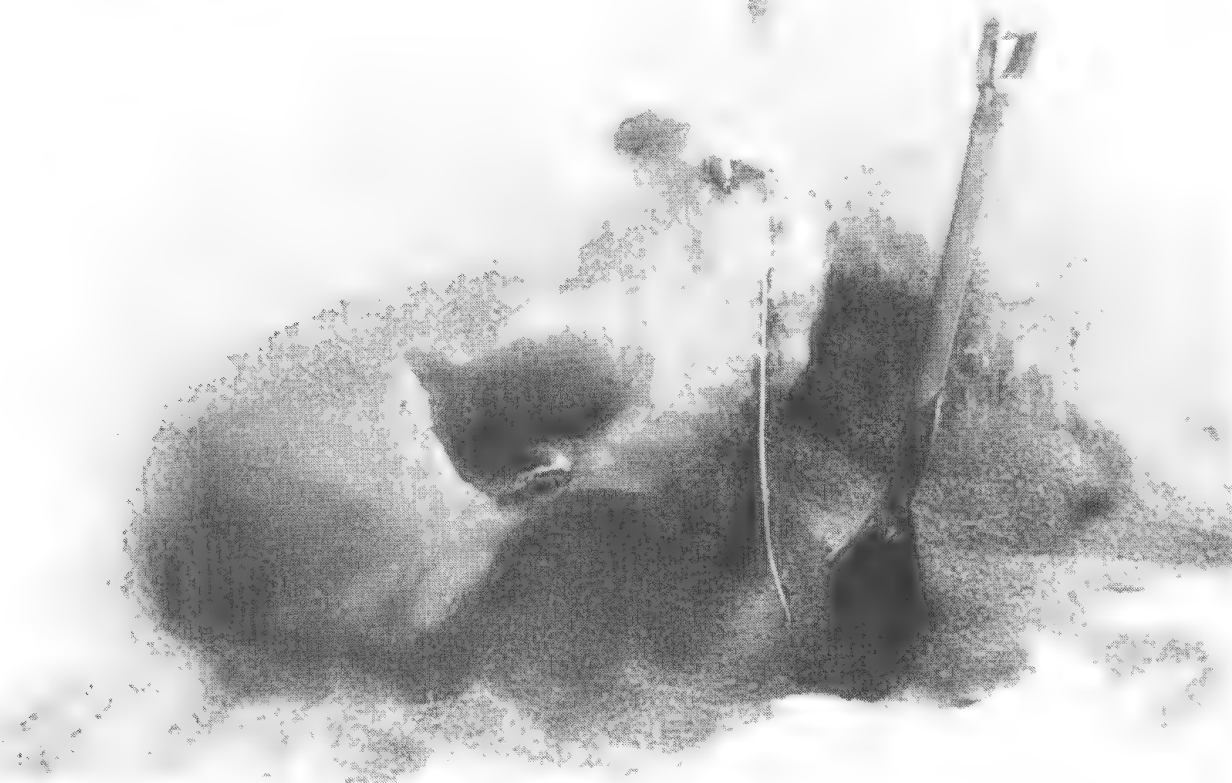


FIGURE 2. Posterior end of the almost-complete skull of specimen A at Parham shown at the beginning of excavations. Note the coarse layer of shell grit, a storm deposit, in which the skull was lying. Photo: J. K. Ling.

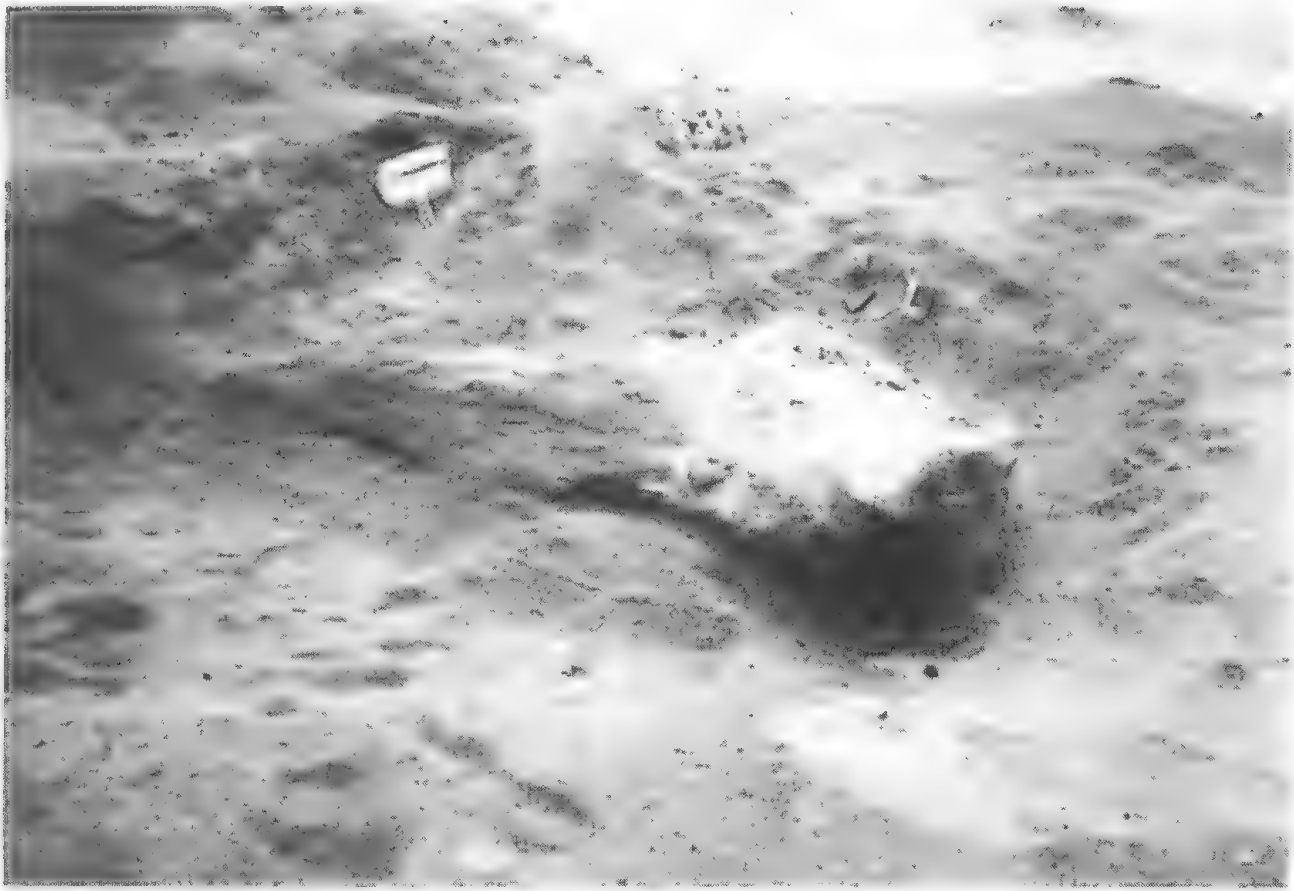


FIGURE 3. Lateral view of specimen B at Parham after excavations were complete. Photo: N. Pledge.

Holocene sediments north of Adelaide and compares them with other *P. macrocephalus* bones found on the eastern shores of Gulf St Vincent.

MATERIALS AND METHODS

In 1989 Australian Consolidated Industries (ACI) discovered two large skulls in their shell grit mines near Parham, 70 km north of Adelaide. In 1990 another skull was reported in a smaller pit at Port Gawler, 40 km southeast of Parham. Over the last 50 years whale bones have also been found along Adelaide beaches and donated to the South Australian Museum (SAM).

The specimens studied were collected from various situations and locations (Table 1, Fig.1). Specimens A, B and C were found in pits being excavated for shell grit; A and B from the ACI pit north of Parham where, according to ACI personnel, other bone fragments have appeared during digging operations, and C was from a pit used by the owners of the property "Buckland Park". Some donated specimens (F, I) were

picked up along Adelaide beaches after becoming exposed by storms. One set of bones (E) was found while the collector was snorkelling. Specimen I was found while dredging sand.

Most of the skeletal material is registered in the Palaeontology and Mammalogy collections of SAM but because the skulls found near Port Gawler (specimen C) and Parham (A, B) were too fragile to move, they were studied and photographed *in situ*. The more robust mandible and teeth which lay beneath the skull of specimen A were collected and treated with bedacryl, a consolidant and hardener. The vertebra associated with specimen A was collected from near the skull by ACI personnel. Specimen I was studied and photographed by the SAM but is held privately.

Skulls of specimens A, B and C were measured from scaled photographs taken with a 35 mm camera.

Sex was determined from tooth, mandibular, alveolar and vertebral size and/or development when compared with skeletons of recently stranded *P. macrocephalus* held at SAM or described in the literature.

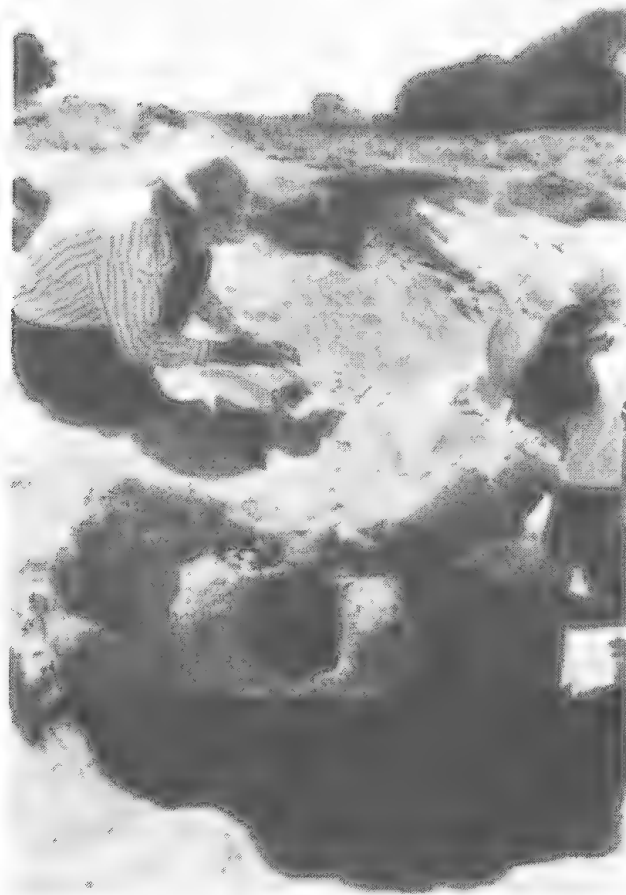


FIGURE 4. Posterior view of specimen C at Port Gawler after excavations were complete. Photo: L. Queale.

RESULTS

Identity

The bones and teeth were identified as *P. macrocephalus* after comparison with reference specimens held at SAM and descriptions in Flower (1869). Their identification reliabilities (ID) were rated as follows: 1 = certain, 2 = probable, 3 = uncertain (Table 1). Table 2 lists the measurements obtained from the specimens.

In all three almost-complete skulls (A,B,C; all ID = 3) the tall supraoccipital and maxillary crest was missing (Fig. 2, 3, 4). The shape of the dorsal surface of the rostrum was consistent with *P. macrocephalus*. The condition of specimen B had deteriorated badly by the time its study began and its features were not as clear as in the other skulls. However, the distinctive shape of the rostrum and exoccipitals (Fig. 3) made the identification as *P. macrocephalus* certain. Associated with specimen A were 23 well-

preserved teeth, a distinctively-shaped mandible (alveoli eroded away), bullae and periotics. All compared well with recent *P. macrocephalus* (Fig. 5, 6).

Cetacean caudal vertebrae are difficult to identify because many of the features used for distinguishing species are much reduced in this part of the vertebral column. Specimen D (Fig. 7), a caudal vertebra (ID = 2), was oval when viewed anteriorly and it had a simple, reduced neural spine. It was very similar to the 11th caudal vertebra of a large *P. macrocephalus* (SAM M5585) and the description of the same vertebra in Flower (1869). In contrast, the caudal vertebra of a *B. musculus* at SAM was almost round and the neural spine was bipartite anteriorly. No comparative material of *E. australis* was available so we could not be certain that it was not this species.

Specimen E (Fig. 8) consisted of an almost complete mandible with 19 large alveoli, one caudal vertebra and two parts of the cranium (possibly portions of the maxilla and occipital). All were clearly *P. macrocephalus* (ID = 1).

Specimen F (Fig. 9) was possibly part of the exoccipital or squamosal region of a medium to large whale. It did not seem to be part of *Balaenoptera* spp., *M. novaeangliae* or *E. australis*. However, its identification here as *P. macrocephalus* is uncertain (ID = 3).

The part right mandible (G) had six large alveoli (Fig. 10) and was probably from the mid section of the lower jaw. It was clearly *P. macrocephalus* (ID = 1).

Specimen H (Fig. 11) was a humerus which compared well (ID = 1) with the sperm whale features described by Flower (1869), including the long tubercle on the radial border connecting with the tuberosity.

Specimen I (Fig. 12) consisted of two parts of the skull, possibly incomplete frontals, of a large cetacean. The identification assigned to *P. macrocephalus* is uncertain (ID = 3).

Size, sex and number of animals

Adult male and female *P. macrocephalus* are very dimorphic in size, males growing to 18.3 m and females to only 12.5 m (Rice 1989). There is also a distinct difference in the size of the teeth (Rice 1989), making it possible to distinguish the sexes at all ages. Sufficient reference material of different sexes and relative ages is held at SAM, supplemented by published measurements

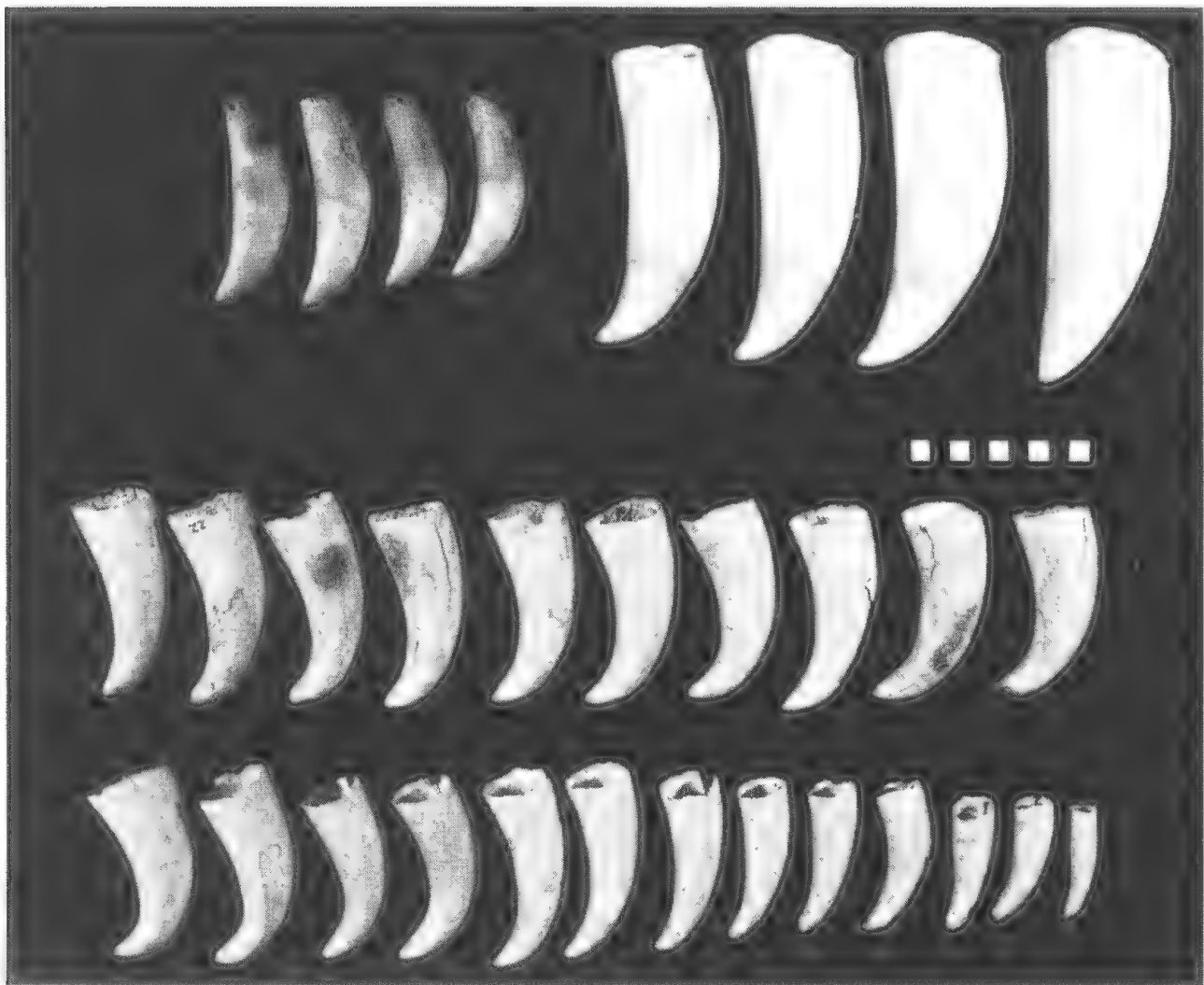


FIGURE 5. Teeth of Parham specimen A (top two rows) compared with recently stranded specimens in the Museum's collection. Four large teeth on bottom left are from the mid-mandible of a 13.5 m male (SAM M14442). Four smaller teeth on lower right are from the mid-mandible of a 10.2 m female (SAM M16613). Scale bar is in cm.

(Omura *et al.* 1962), to compare with the specimens from the present study and make some conclusions regarding their size and sex (Table 2).

The teeth of specimen A were open-rooted (Fig. 5), as would be the case in a young animal, yet they were only slightly smaller than the teeth of adult females (SAM M16612, SAM M16613) with almost occluded dental cavities. The length of the mandible was about the same as that of a 12.2 m female (SAM M16612). Specimen A was therefore from a subadult male, about 12 m long. Specimen B was a very damaged skull, about 2.1 m long. By its size it could have been from a female or a young male. Specimen C was a skull of about the same length as that of an 8.0 m male *P. macrocephalus* (SAM M15007). Without teeth or a mandible it was not possible to say

whether it was from a female or male.

The remaining specimens were more incomplete but it was still possible to estimate their sex and/or length in most cases. The large caudal vertebra (specimen D) was the same size as the 11th caudal vertebra of the 14 m male described by Omura *et al.* (1962). It appeared to lack fused epiphyses although this was difficult to determine because the surfaces were very worn. For specimen E, the length of the almost-complete mandible, size of the mandibular alveoli and depth of the mandibular symphysis were all greater than for a 12.2 m female (SAM M16612). These comparisons suggest that it was from a male, about 12–13 m body length. Specimen G, a part right mandible, could not have been the same animal as E, also a right mandible. The depth of the symphysis and the size of the alveoli, at least

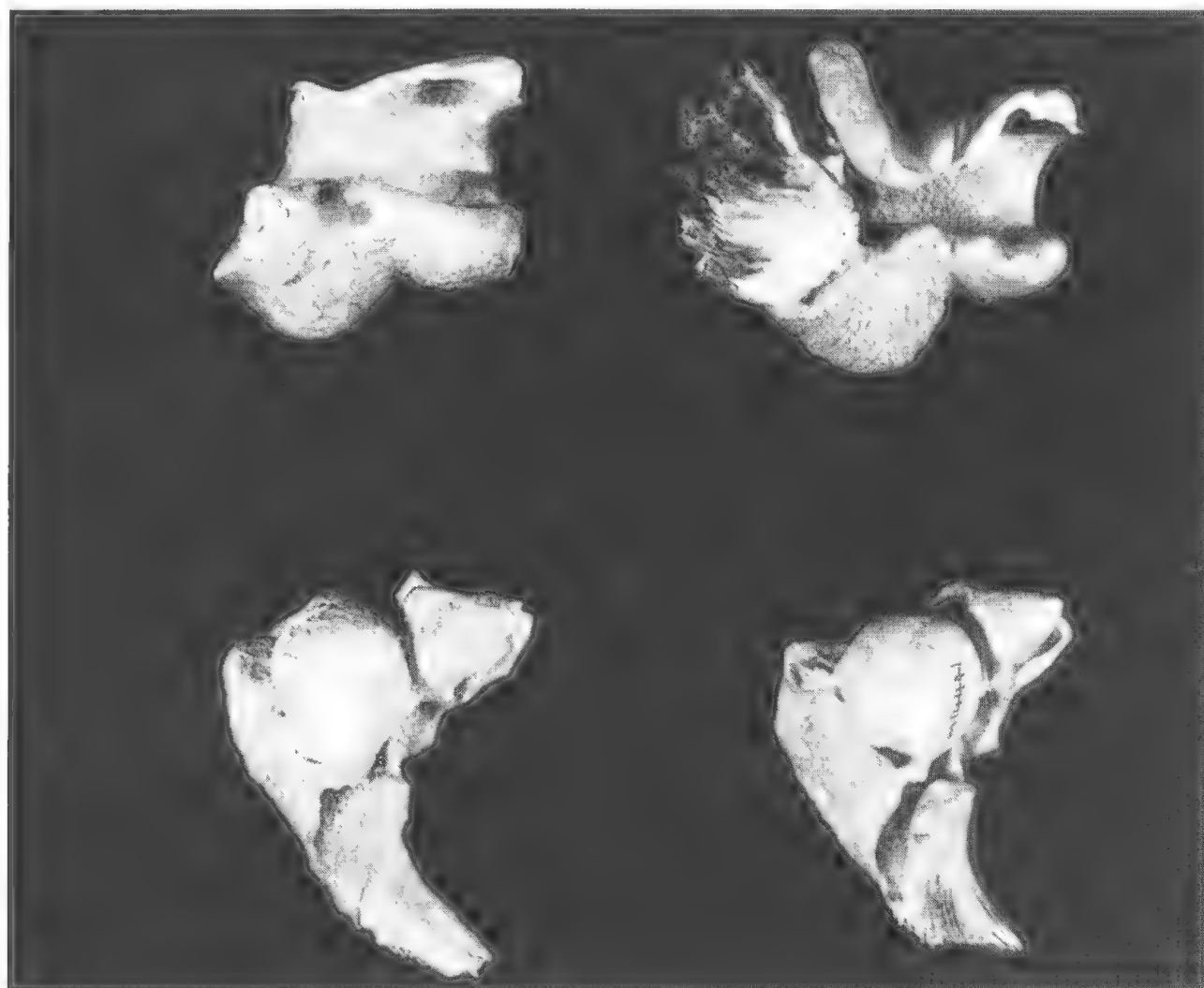


FIGURE 6. Bulla (top left) and periotic (bottom left) of Parham specimen A compared with the same (right) of a recently stranded *P. macrocephalus* (SAM M14441) of unknown length and sex. Left periotic is 62 mm maximum length.

as represented in this piece, were both less than in a 13.5 m male (SAM M14442) which suggests that it was from an animal about 12 m long. The humerus (specimen H) was slightly longer than that of an adult female (SAM M16612) and its proximal epiphysis was not fully fused. It was probably from a 12–13 m male. No size or sex was assigned to specimens F and I.

At least six individual *P. macrocephalus* were represented in the material available (Table 2). The skulls of A, B and C were three individuals. Specimens E and H could have been from the same animal, which was different from G. Specimen D was from an animal larger than those described above. The total number of each sex/size category therefore represents three subadult males (about 12–13 m long), one adult male (about 14 m) and two unsexed animals about 8 and 11 m.

Geological Age

It was not possible to assign a geological age to all specimens. The three skulls (A,B,C) found in shell grit pits at Parham and Port Gawler all lay at approximately the same depth (1–2 m) below the surface of the ground and were deposited in a deep layer of coarse shell grit, a storm deposit, overlaid with finer material (Fig. 2). The coarse shell grit in which specimen C was found has been radio-carbon dated at 2020 ± 90 years BP, taking into account the reservoir effect (A. Belperio, pers. comm.). The age of the storm deposit layer in the ACI bed has been estimated at approximately 2000 years BP (A. Belperio, pers. comm.). Specimens A and B were located 700 m from the present-day shore of Gulf St Vincent and about 200 m from each other. Specimen C was 1 km inland (i.e. from the

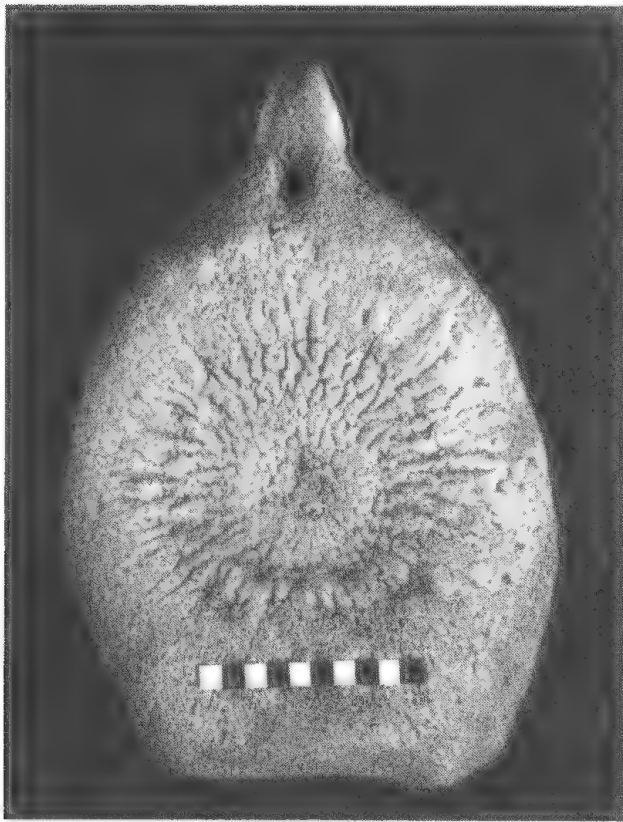


FIGURE 7. Caudal vertebra (specimen D) from Tennyson/North Grange showing weathered anterior surface of centrum with epiphysis missing. Scale bar is in cm.

landward edge of the mangroves).

The remaining bones were found in various situations at, or very near, the present shoreline. Most were found on the beach but one (E) was found well below low water mark and partially buried in the sand under 1.5 m of water and another was uncovered while dredging sand. It was not possible to estimate the accurate geological age of any of these specimens because the sands in or on which they were found were not stable and therefore not conducive to comparative stratigraphy. The sediments were, however, Holocene in origin and therefore less than 10 000 years BP.

DISCUSSION

The skulls found in Holocene sediments near Parham and Port Gawler were dated at about 2000 years BP, judging by the age of the shell grit in which they lay. Radio-carbon dating of the bones themselves seemed inappropriate because of the 1000 year correction factor suggested by

Gordon and Harkness (1993) to adjust for the 'reservoir effect'. The reservoir effect increases from lower to higher latitudes in the Southern Hemisphere but *P. macrocephalus* ranges over a wide latitudinal area. Adult males venture further south, as far as 70° S (Leatherwood and Reeves 1983), than females and juvenile males which rarely go further than 45° S. Since the animals described in this study were not adult males and therefore would not have travelled very far south, the reservoir effect correction factor would probably be less than 1000 years had their bones been carbon-dated. Radio-carbon dates for recently stranded *P. macrocephalus* along the Australian coast are needed to confirm this hypothesis.

The skulls were well inland (700 and 1000 m) from the present-day coast and record a time when the coast was inland of its present position. The fact that one of the Parham skulls was found with its mandible and teeth still adjacent to it suggests that it was an intact specimen, not a beached washed skull, when it was deposited. South of Parham, shells within the beach ridges of the St Kilda Formation have been radio-carbon dated. At 1 km inland, their estimated age is 3010 ± 80 years BP and just behind the seaward ridge (*ca* 300 m inland) the estimated date is 1820 ± 50 years BP (A. Belperio, pers. comm.).

It is possible that the animals stranded at the same time, although this would be impossible to prove even with accurate dating of the specimens. The two Parham skulls lay at the same depth and within 200 m of each other. The Port Gawler skull was in the same sediment layer about 40 km south of the Parham skulls. Since writing this paper, another *P. macrocephalus* mandible has been found at the Parham site but the mining machinery accidentally smashed it before it could be studied. There are no records of mass strandings of *P. macrocephalus* in South Australia (Kemper & Ling 1991) but several have been recorded in Tasmania (Nicol & Croome 1988). The eastern shores of Gulf St Vincent have been the site of two mass strandings of other species: five short-finned pilot whales, *Globicephala macrorhynchus*, at St Kilda in 1903; and about 250 false killer whales, *Pseudorca crassidens*, along the coast between Parham and Port Gawler in 1944 (Hale 1945). In Gulf St Vincent most of the cetacean strandings occur along the eastern side, possibly as a result of the prevailing southwesterly winds (Kemper & Ling 1991).

The estimated body lengths of the animals

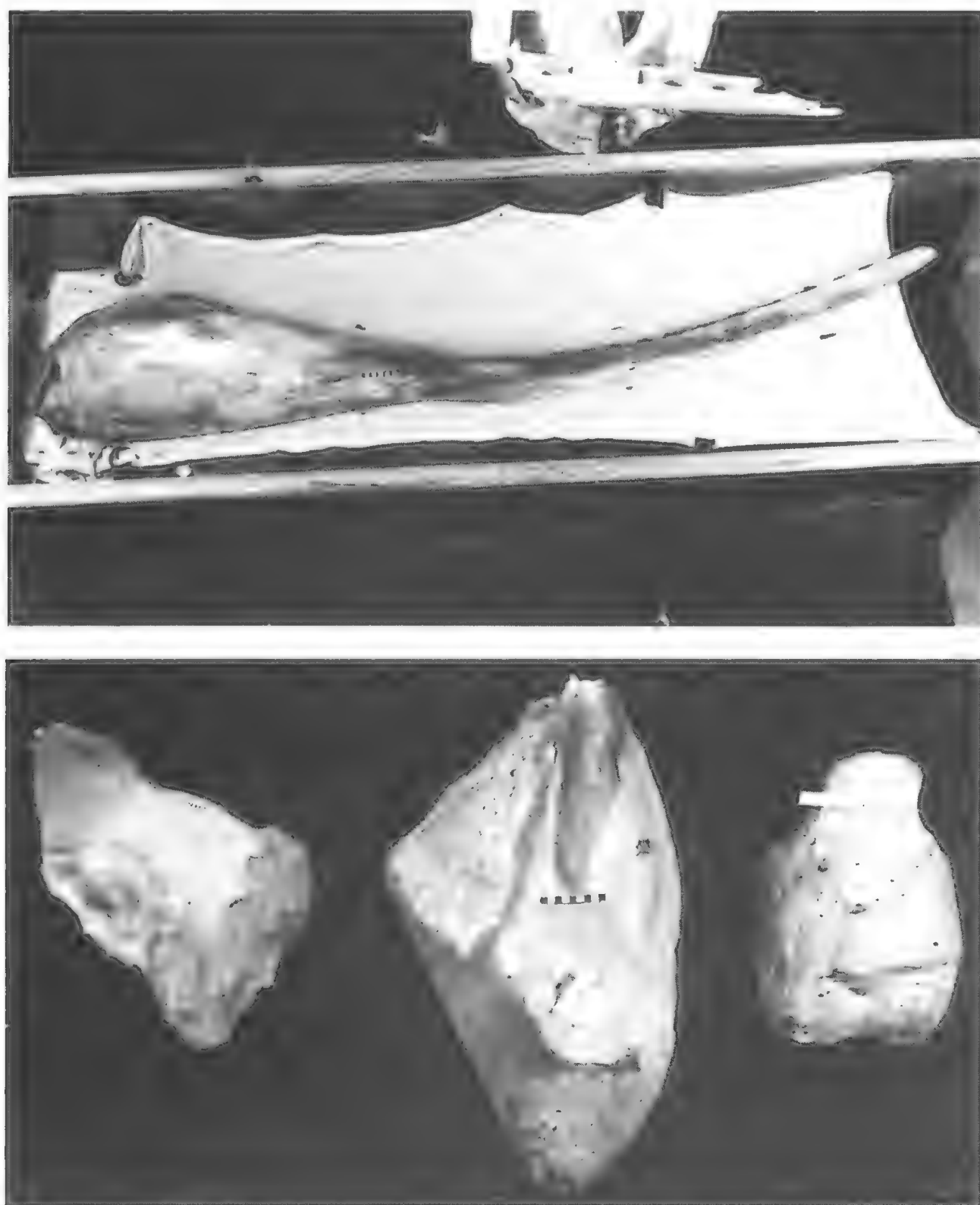


FIGURE 8 Upper photograph: Specimen G (being held) and mandible of specimen E. Lower photograph: two cranial pieces (possibly parts of the occipital and maxilla) and caudal vertebra of specimen E.

studied here were 8–14 m. Three of the six animals were clearly subadult males, about 12–13 m long. Two were a little smaller (8 and 11 m) and may have been either male or female. If a

mass stranding of *P. macrocephalus* did occur, it may have been a school of bachelor males. Such associations are well known and include males generally less than 12 m body length (Rice 1989).



FIGURE 9. Specimen F, a part-cranium (possibly part of the exoccipital or squamosal region), from Tennyson. Scale bar is in cm.

Schools of both bachelor males and breeding females are known to mass strand, and at about the same frequency (Rice 1989).

Holocene coastal marine sediments are extensive in South Australia (Belperio *et al.* 1983) and may be the source of many cetacean bones, some of which could be subfossil. These sediments have been deposited during the last 10 000 years. They are especially abundant on the eastern side of Gulf St Vincent where there is a series of inland beach ridges representing old

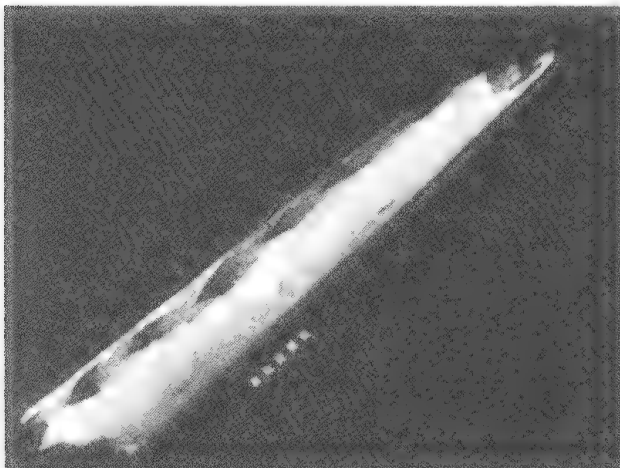


FIGURE 10. Specimen G, a partial right mandible, from Largs Bay, showing distinct alveoli typical of *P. macrocephalus*. Scale bar is in cm.

shorelines (Belperio *et al.* 1983). The unconsolidated shell beds, and samphire and tidal flat deposits are called the St Kilda Formation (Firman 1966). It is 2–3 m thick and lies above the Pleistocene Glanville Formation, a cemented, shelly limestone. Layers of coarse shells, probably storm deposits, occur in the St Kilda Formation.

The *P. macrocephalus* specimens found along Adelaide beaches were highly unlikely to have been from whaling because this species inhabits the deep ocean. The waters of Gulf St Vincent are very shallow (less than 50 m), and the continental slope is 250 km south of Port Gawler. The two whaling stations recorded in Gulf St Vincent, one at Port Noarlunga, just south of Adelaide, and one at Cape Jervis, about 100 km south of Adelaide (Kostoglou & McCarthy 1991), would not have taken sperm whales.

Without radio-carbon dating the specimens which were found along beaches the possibility exists that they were from strandings in the last few hundred years and not subfossil. However, a thorough search of whale stranding records held at SAM and a public appeal in 1987 to find out if any sperm whales had ever been recorded as stranding along the Adelaide coast failed to find any evidence of such an event in the last 110 or so years (Kemper & Ling 1991). A dead animal the size of *P. macrocephalus* would certainly have been noticed in a populated area such as Adelaide. *P. macrocephalus* strandings have been recorded on the north coast of Kangaroo Island, near the entrance to Gulf St Vincent and over 100 km southwest of Adelaide (Kemper and Ling 1991). There have been no reported sightings of live sperm whales in Gulf St Vincent (SAM records).

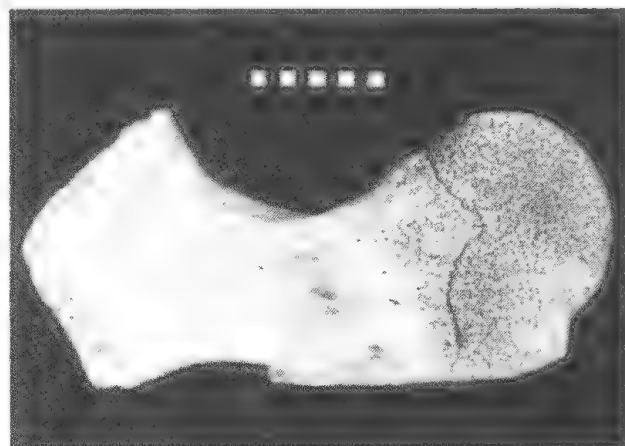


FIGURE 11. Specimen H, a left humerus, from Largs Bay. Scale bar is in cm.

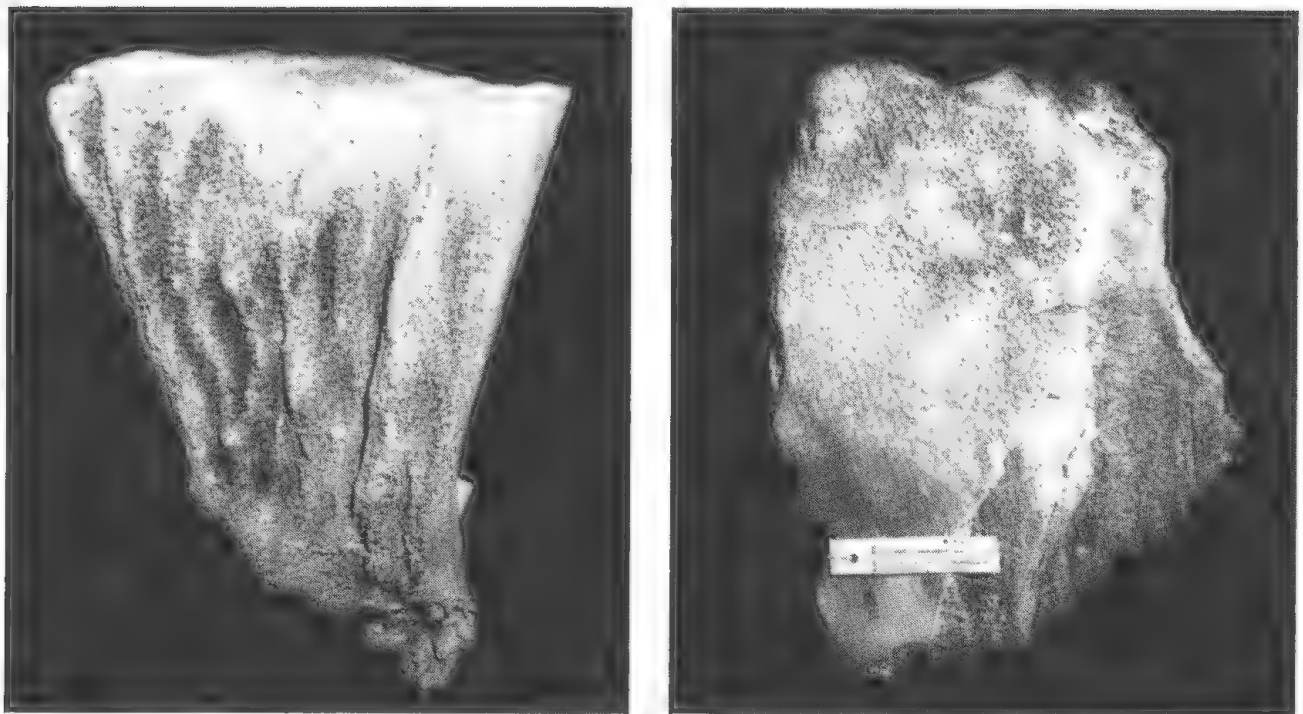


FIGURE 12. Specimen I, two part-crania (possibly part of the frontal region), from Sellicks Beach. The label is 10 cm long.

ACKNOWLEDGMENTS

We would like to thank Australian Consolidated Industries and their staff, Trevor Gilbert, Trent Baker and David Flew, for alerting us to the whale skulls at their shell grit pit near Parham. They also generously gave us logistic support during the excavation. We are also grateful to the owners of Buckland Park for allowing us access to the shell grit pit and to Lyn Pedler for making us aware that the skull was there. The help of all those who assisted with the excavations, especially Ben McHenry, Jim McNamara, Lynette

Queale, Tim Verscoyle, Jenni Thurmer, Lyn and Janet Pedler, and members of the Mammal Club of the Field Naturalists Society of SA, is appreciated. We thank Jim McNamara for consolidating the teeth and mandible of specimen A. Tony Belperio made available the ages of the Holocene deposits and commented on the results of our study. Graham Carpenter made many useful suggestions on the manuscript. Thanks go to the people who donated the specimens discussed in this paper. Gillian Taylor provided references on the reservoir effect and Trevor Peters took the photographs.

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DESCRIPTION OF A NEW AUSTRALIAN MITE (ACARINA : TROMBIDIOIDEA), WITH COMMENTS ON SUPERFAMILY CLASSIFICATION

R. V. SOUTHCOTT

Summary

A new larval mite, *Yurebilla gracilis* gen. et. sp. nov., is described from the Mount Lofty Ranges, South Australia, from among soil and leaf litter, free-living. A new family, Yurebillidae fam. nov. is proposed for it. The classification of the superfamily Trombidoidea and related groups is discussed.

DESCRIPTION OF A NEW AUSTRALIAN MITE (ACARINA: TROMBIDIOIDEA), WITH COMMENTS ON SUPERFAMILY CLASSIFICATION

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SOUTHCOTT, R. V. 1996. Description of a new Australian mite (Acarina: Trombidioidea), with comments on superfamily classification. *Records of the South Australian Museum* 29(1): 55-62.

A new larval mite, *Yurebilla gracilis* gen. et. sp. nov., is described from the Mount Lofty Ranges, South Australia, from among soil and leaf litter, free-living. A new family, Yurebillidae fam. nov. is proposed for it. The classification of the superfamily Trombidioidea and related groups is discussed.

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The superfamily Trombidioidea is a large, cosmopolitan, diverse group of Acarina. Various attempts to classify its members into family, and higher and lower, groupings have been made over many years, since the pioneer studies of Berlese (1910, 1912). All students of the Trombidioidea (and other Parasitengona) have had to face the fact that extreme heteromorphy exists between the larval and postlarval instars, so that in many cases, following the small numbers of correlations that have been achieved between the larvae and the postlarvals, a dual generic and specific nomenclature has evolved (see e.g. Southcott 1994). Subsequently, revision of the classification of the Trombidioidea were made by Oudemans (1923), Thor (1935a, b), Thor & Willmann (1947), Feider (1959, 1979), Vercammen-Grandjean (1973), Robaux (1974), Southcott (1982, 1987a,b) and Welbourn (1984, 1991). Welbourn (1984) estimated that the Trombidioidea contained 'some 225 genera, and more than 3000 species', and contained 'an unsettled number of families'.

He divided the superfamily into eight tribes, using a total of 41 larval characters, largely based on chaetotaxy; characters of the adults were not used. In his second cladistic revision (1991) he followed Feider in elevating the previous group Trombidioidea to a 'subcohort Trombidiina' (Feider had used the term 'phalanx'), which he divided into four superfamilies, using a total of 19 larval characters and six adult characters.

In the present paper is described a new trombidoid larva, obtained by systematic Berlese funnel extractions of samples of soil and litter from the Mount Lofty Ranges, South Australia.

As the characters of this larva do not fit into any of the existing classifications of the Trombidioidea including the most recent ones of Welbourn (1984, 1991), a new family, genus and species is proposed. The classification of the Trombidioidea will be discussed.

MATERIALS AND METHODS

The mites were collected as larvae by systemic Berlese funnel extractions from soil and litter samples taken in the Mount Lofty Ranges, South Australia. All were collected free-living; none was attached to an arthropod host. Initial extracts were made into 70% ethanol, later specimens were collected live in the hope of making significant biological observations.

Students of the higher classification of the Trombidioidea have used the suprageneric terms with various expanded or restricted definitions, with varying status. Thus one finds the term referring to the trombiculid mites used as Trombiculini, Trombiculinae, Trombiculidae and Trombiculoidea, with varying content, similarly with Chyzeriini, Chyzeriinae, Chyzeriidae and Chyzerioidea, and the same applies with other trombidoids. In order to save redefining each term as it is discussed, as far as possible family terms will be used, with -idae endings, without a formal commitment to the ultimate status of the taxon.

All drawings were made using an Ortholux/Laborlux microscope, with a drawing apparatus. All measurements are in micrometres (μm) unless otherwise stated.

Setal and other coding follows Southcott (1992,

1993, 1994). The holotype and paratypes are deposited in the South Australian Museum (SAM).

SYSTEMATICS

YUREBILLIDAE new family

Diagnosis of larva

Trombidoidea. Eyes two on each side, sessile. Prodorsal scutum with anterior nasus, six non-sensillary setae and two sensillary setae. Scutellum absent. Palpal and pedal supracoxalae absent. Gnathosoma without chitinous mouth-ring. Coxalae I & II contiguous, with urstigma on posterior part of coxa I. Coxal setal formula 2, 1, 1: medial coxala I and coxalae II & III nude. Leg segmental formula 6, 6, 6. Leg tarsi with 3, 3, 2 claws (i.e. posterior claw of tarsus III absent). Leg tarsi without ventral sensillae (eupathididae). Palpal femur and genu without setae.

Postlarval stages not known.

Type genus *Yurebilla* gen. nov.

Remarks

Yurebillidae resembles the family Allothrombiidae, but differs by having a nude medial coxala I and in lacking a scutellum, and in having a coxal setal pattern of 2, 1, 1 instead of 2, 2, 1.

The family at present contains only the genus with its type species *Y. gracilis* sp. nov.

Yurebilla gen. nov.

Diagnosis of larva

With the characters of Yurebillidae, and : odontus (palpal tibial claw) bifid. Trochanteralae 1, 1, 1. Femoralae 5, 4, 4. Genuae 6 (4Sc + 1So + 1Vs), 5 (3Sc + 1So + 1Vs), 4 (3Sc + 1So).

Type species *Yurebilla gracilis* sp. nov.

Etymology

The term *Yurebilla* is derived from the aboriginal (Kaurna) name for Mount Lofty, South Australia (Ellis 1976).

Yurebilla gracilis sp. nov.
(Figs 1A–C, 2A–C)

Material examined

Holotype: South Australia, Mount Lofty

(summit), in soil and leaf litter in *Eucalyptus obliqua* forest, (sample TX272), 4.i.1988, R. V. Southcott, extracted by Berlese funnel 9.i.1988, larva (SAM ACA985).

Paratypes: South Australia. Mount Lofty summit, site as for holotype, sample TX280, 5.iv.1988, larva ACB1019, RVS, extracted by Berlese funnel 12.iv.1988. Same site, sample TX297, 18.i.1990, five larvae ACB1121, 1122A–D, RVS, extracted 20.i.1990; one larva ACA1123, extracted 21.i.1990, RVS. Waitpinga Beach, southern Mount Lofty Ranges, 17.xi.1953, RVS, sample TX60, one larva ACB606, extracted into ethanol. All in SAM.

Description of larva

The following description is based on the slide-mounted holotype, supplemented by paratypes. Metric data for the holotype and paratypes are given in Table 1.

Colour in life orange. Idiosoma 625 long, 295 wide; total length to tip of chelicerae 655 (the same idiosomal and total measurements before mounting were 584, 249, 627 respectively). Dorsal scutum oblong, with undulate borders; anterior end produced into a blunt-pointed nasus; scutum weakly chitinized, without special markings. Scutalae pointed, nude; AM setae near root of nasus; AL setae small, arising slightly anterolateral to sensillary setae bases; PL setae arise near posterolateral angles of scutum. Sensillary setae slender, tapering, with fine setules in distal half. Dorsal scutum with a central longitudinal rod (crista), 30 long, from behind level of AM setae to about 6 posterior to level of sensillary setae bases. Eyes: each lateral eye pair lateral to posterior half of scutum; eyes circular, anterior 9 across, posterior 6 across.

Dorsum of idiosoma with 20 setae, arranged 2, 4, 6, 2, 4, 2; first pair about one-quarter back from anterior end of dorsum (hence no 'ocular' setae are present). Setae slender, mostly almost spiniform (a few faint setules present); the most posterior pair with a few adnate, slight setules as is the case with the most posterior ventral pair. All idiosomal setae arise from a small basal plate.

Ventral surface of idiosoma with a pair of almost spiniform setae, 18 long, arising well behind coxae II. Behind coxae III are three pairs of similar setae, 18–24 long, followed by the posterior pair, 40 long. Lateral coxala I at the anterolateral angle of the coxa, with three or four setules; medial coxala I and coxalae II and III slender, spiniform. Anus apparently imperforate.

Legs: lengths I 240, II 185, III 210 (including

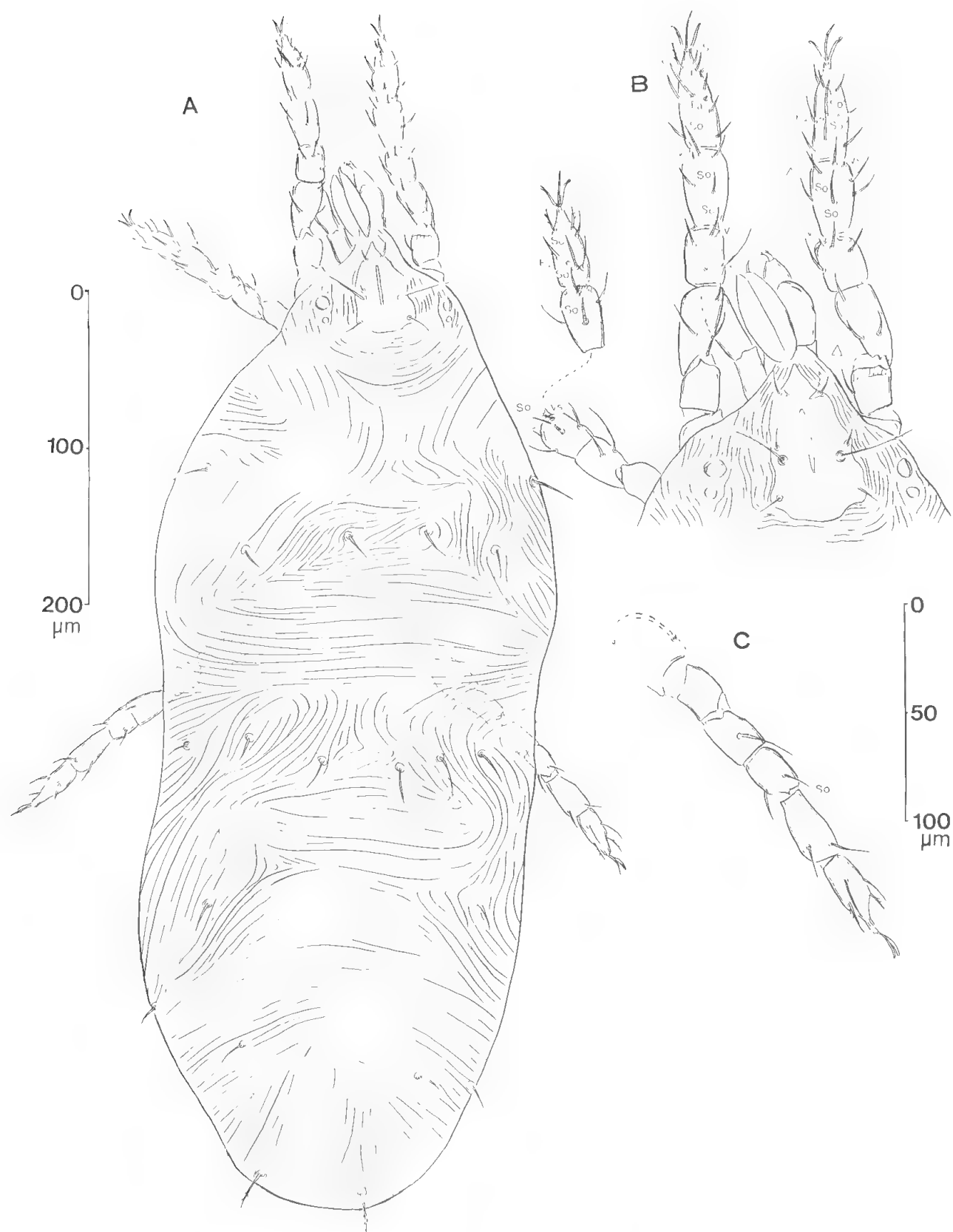


FIGURE 1. *Yurebilla gracilis*, gen. et sp. nov., larva, holotype. **A**, Dorsal view, entire. **B**, Propodosoma and adjacent structures, dorsal view. **C**, Leg III, dorsal view. (Figures to standard symbols; each to nearer scale.)

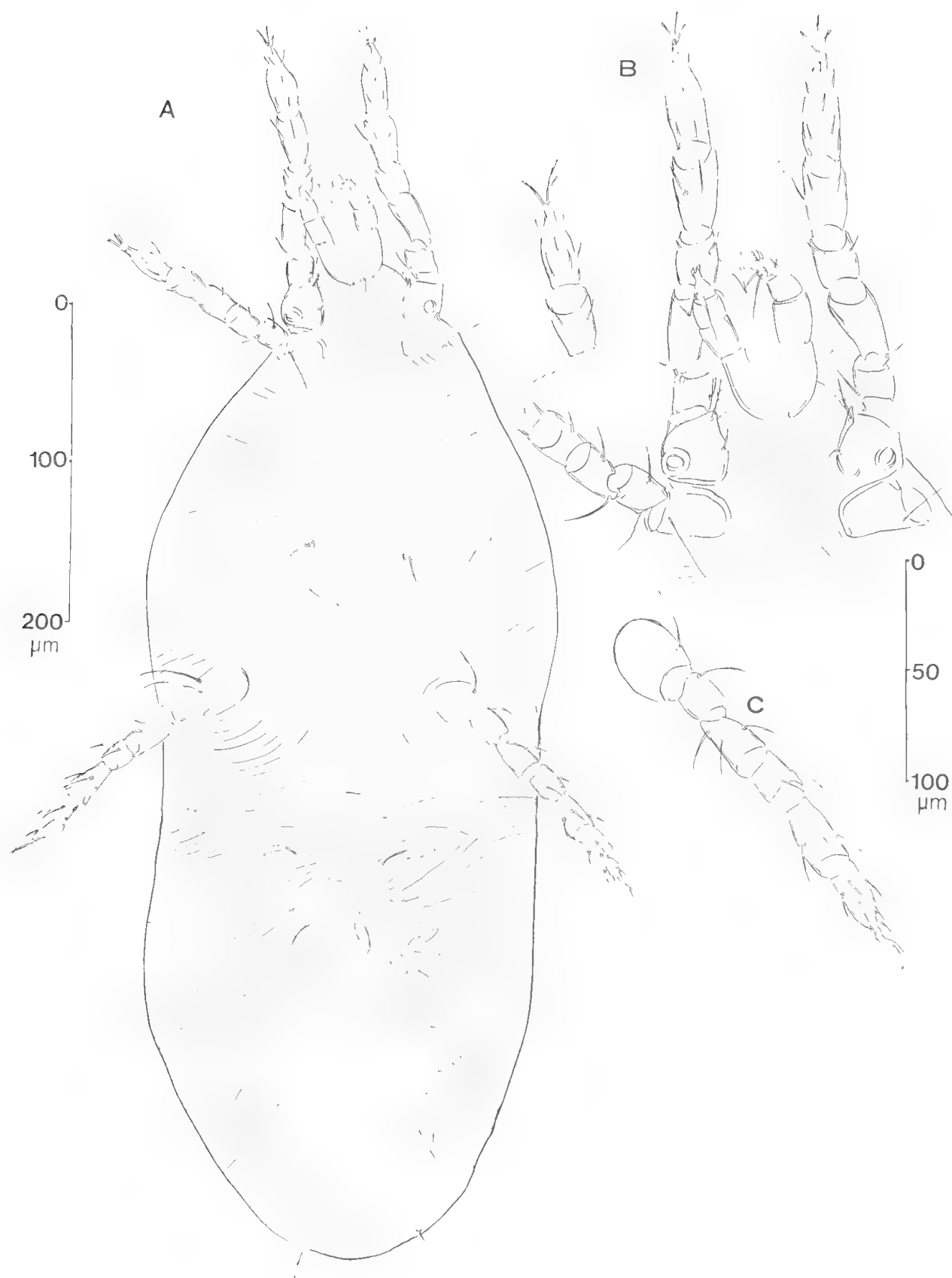


FIGURE 2. *Yurebilla gracilis*, gen. et sp. nov., larva, holotype. A, Ventral view, entire. B, Propodosoma and adjacent structures, ventral view; symbols standard. C, Leg III, ventral view. (Each to nearer scale.)

TABLE 1. Metric data for *Yurebilla gracilis* gen. et. sp. nov., larva

Character	Holotype	n	range	mean	s.d.	c.v.
LN	c. 15	9	10-23	17.7	3.97	22.5
MA	32	9	27-32	30.4	1.51	5.0
AW	29	9	29-37	33.7	2.45	7.3
PW	32	9	32-38	34.9	2.26	6.5
SB	22	9	22-30	26.3	2.24	8.5
MSA	29	9	25-31	28.7	1.73	6.0
ASB	54	9	43-58	52.6	4.30	8.2
PSB	32	9	29-36	32.8	2.39	7.3
L	86	9	77-92	85.2	5.02	5.9
W	40	9	40-57	49.7	5.20	10.5
AP	23	9	20-27	23.7	2.45	10.3
SA	7	9	7-9	7.44	0.726	9.8
SP	18	9	16-21	18.7	1.50	8.0
AM	19	9	13-20	17.9	2.32	12.9
AL	13	9	10-15	12.6	1.33	10.6
PL	18	9	18-23	21.6	1.42	6.6
AMB	19	9	18-23	19.6	1.59	8.1
SE	53	9	49-59	54.2	2.68	4.9
DS	24-33	9	33-40*	36.2*	2.05*	5.7*
MDS	22	9	22-25*	22.9*	0.928*	4.1*
PDS	33	9	33-40*	36.2*	2.05*	5.7*
FeI	37	9	33-46	41.2	4.52	11.0
GeI	28	9	22-29	25.6	2.35	9.2
TiI	38	9	35-43	37.3	2.65	7.1
TaI(L)	41	9	38-45	42.3	2.00	4.7
TaI(H)	22	9	17-23	19.6	2.01	10.3
TiI/GeI	1.36	9	1.28-1.64	1.46	0.104	7.1
FeII	27	8	27-34	31.1	2.23	7.2
GeII	19	9	18-22	20.8	1.48	7.1
TiII	23	9	23-33	28.4	3.32	11.7
TaII(L)	42	9	29-42	36.6	3.97	10.9
TaII(I)	16	9	16-19	16.4	1.01	6.2
TiII/GeII	1.21	9	1.19-1.61	1.36	0.140	10.3
FeIII	38	9	33-40	36.3	2.65	7.3
GeIII	22	9	19-24	21.8	1.79	8.2
TiIII	39	9	28-40	35.1	3.66	10.4
TaIII(L)	33	9	33-40	36.2	2.49	6.9
TaIII(H)	18	9	14-18	16.1	1.36	8.5
TiIII/GeIII	1.77	9	1.40-1.80	1.62	0.137	8.5
SA/SP	0.39	9	0.35-0.45	0.400	0.0350	8.8
AW/AMB	1.53	9	1.53-1.89	1.72	0.144	8.4

* For maximum values

coxae and claws). Leg scobalae slender, spiniform.

Leg specialised setae: SoGeI.76d(17), VsGeI.76ad(5), SoTiI.39d(19), SoTiI.88d(16), VsTiI.87pd(4), SoGeII.62d(14), VsGeII.90d(3), SoTiII.36d(11), SoTiII.92d(10), SoGeIII.53d(12).

Tarsus I with FaTaI.53ad(minute), SoTaI.55d(13), SoTaI.85d(13) (arising from a distinct boss). Tarsus II with SoTaII.38ad(15), FaTaII.40pd(2).

Tarsal claws: on tarsus I & II the laterals (a & p) falciform, smooth, equal, empodium (m)

slender, curved, over-reaching laterals. On tarsus III anterior claw similar to laterals of I & II, but larger; empodium as for I & II, but longer, over-reaching anterior claw; posterior claw absent.

Gnathosoma: chelicerae bases slender, 42 long by 26 across (combined); digits curved, pointed, simple, about 7 long. Galeala (protorostral seta) slender, spiniform, c. 5 long. No deutorostral or tritorostral setae identified, nor basis capituli setae. Palpi slender, femur and genu without setae, palpal tibia with three slender, spiniform setae.

Palpal tarsus a blunt cone, 6 long, by 4 wide at

base; on it three simple slender setae can be identified under oil immersion, longest seta 20 long. Palpal tibial claw (odontus) bifid, the tines curved, lightly separated, blunted, the medial tine the larger.

Etymology

The word *gracilis* is from Latin, for slender.

REMARKS ON THE CLASSIFICATION OF YUREBILLIDAE AND YUREBILLA

The presence of an urstigma (Claparède's organ) in larval *Yurebilla*, and its general facies, clearly defines *Yurebilla* as a member of the Trombidioidea, using this term in a customary sense. The only other larva of the Trombidiformes with an urstigma is *Calypstostoma* (Calypstostomatidae). A variety of other characters has been responsible of the separation of Calypstostomatidae from the Trombidioidea; among those of the larva the presence of multisetose coxae is one of the most notable (see e.g. Shiba 1976). Welbourn (1991) in fact, on the basis of cladistic analysis, groups the Erythraeoidea and the Calypstostomatoidea in a subcohort Erythraeina of the Parasitengona.

None of the characters used above in defining Yurebillidae is unique among the families of the Trombidioidea, all of which are terrestrial. (We may exclude from further discussion the Hydracarina (Hydrachnoidia of Krantz (1978)), on grounds of general morphology, although they clearly derive from a common ancestry with the Trombidioidea.)

Considering the defining characters given above systematically, the first character given is of two eyes on each side. This character is virtually present throughout the Trombidioidea. Two genera in which eyes are absent are *Beronium* Southcott, 1986b, erected for larva parasitic on a cavernicolous beetle, and *Audyana* Womersley, 1954a, a larva which was collected ectoparasitic on a Malayan scorpion, *Heterometrus longimanus* (Herbst), probably largely nocturnal (see e.g. Harrison 1954). The deutonymph of *Audyana thompsoni* Womersley also lacks eyes (Womersley 1954b). This genus was placed in a family Audyanidae by Southcott (1987a).

A prodorsal scutum is present throughout the Trombidioidea, but only a few genera possess a nasus, in disparate groupings, e.g. *Neotrombidium* (family Neotrombidiidae) (Southcott 1954; Lindquist & Vercammen-Grandjean 1971),

Leeuwenhoeekiinae, family Trombiculidae (many authors). Most trombidoid prodorsal scuta have two sensillary and six non-sensillary setae; exceptions are in the Trombiculidae (e.g. 4 + 2 in Trombiculinae, 5 + 2 in Leeuwenhoeekiinae).

A scutellum (second dorsal scutum) is present in various families of the Trombidioidea, e.g. Trombidiidae and Allothrombiidae, and Microtrombidiidae (including Microtrombidiinae and Eutrombidiinae); *Hexathrombium* in the Eutrombidiinae is unusual in having several dorsal scuta. A scutellum is absent in the Trombiculidae, Chyzeriidae (Southcott 1982) and Trombellidae (Southcott 1986a).

Palpal and pedal supracoxalae appear to be unique to the Chyzeriidae among the larvae of the Trombidioidea, but are present in some larval Erythraeoidea, e.g. *Leptus* (see e.g. Southcott 1992).

A mouth-ring, among the Microtrombidiidae, is found in most, but not all, larvae (see e.g. Southcott 1994). The presence of an equivalent structure, i.e. an expanded lip to the mouth, with a number of fine adhesive units or pads, is seen in the larval Erythraeoidea.

The coxa I & II of each side are contiguous in almost all Trombidioidea, with the urstigma closely associated with coxa I. In the Chyzeriidae coxa I & II of each side are separated (Southcott 1982).

The coxal setal formula of 2, 1, 1 is found in a number of families of the Trombidioidea, e.g. Podothrombiidae, Trombellidae, Chyzeriidae, Neotrombidiidae, and most Microtrombidiidae (*Keramotrombium*, with 2, 2, 1, is an exception), including the Eutrombidiinae. The coxal setal pattern of 2, 2, 1 occurs in the Trombidiidae and the Allothrombiidae. A nude medial coxala I occurs in *Trombidium* (Trombidiidae), Eutrombidiinae of the Microtrombidiidae, and Neotrombidiidae; a setulose medial coxala I is present in larval Allothrombiidae, Podothrombiidae, subfamily Microtrombidiinae of the Microtrombidiidae, Trombellidae and Wondeliinae. (However, Southcott 1994 recorded the larva of *Microtrombidium nitidum* Southcott as having a nude medial coxala I.)

A leg segmental pattern of 6, 6, 6 is generally present in the trombidoid larvae; Chyzeriidae and Trombiculinae have the exceptional pattern of 7, 7, 7 (i.e. divided femora); in Neotrombidiidae, as well as in the Audyanidae, the pattern is 7, 6, 6 (Womersley 1954a). A reduction of the tarsal claws is common in the Trombidioidea, e.g. with many Microtrombidiidae, and ranging through to

a single pedotarsal claw in larval Neotrombidiidae and Audyanidae. Among the larval Trombidoidea only the family Podothrombiidae has ventral sensory setae (eupathidia, eupathidulae) to the tarsi (Robaux 1977; Zhang & Jensen 1995).

A seta is lacking to the palpal femur and genu in the Allothrombiidae (Welbourn 1991; Zhang & Jensen 1995), as is the case in a number of the Microtrombidiinae (Southcott 1994)); other differences are listed above. The larval Trombidiinae lack only a palpal femorala.

If we accept in broad terms, the cladistic analysis of Welbourn (1991) for the larvae (the adult of *Yurebilla* being unknown), we may exclude it from the Tanaupodoidea on the ground of its lacking a lassenia organ (the only larval criterion given) and from the Chyzerioidea on the ground of its lacking elongate tarsi (again, the only larval criterion given). We must then decide whether to allot *Yurebilla* to the Trombiculoidea or the Trombidoidea, each in the sense of Welbourn (1991). According to Welbourn (1991: 164, 165) the only criterion separating these groups is the presence of "Apomorphy number 8" in the Trombiculoidea, i.e. the presence of seta 'theta on femur legs I, II &/or III'. This presumably refers to a solenoidal seta, on the analogy of setae omega, phi and sigma as used by the Grandjean school of setal terminology. This criterion is not understood, as I cannot find any evidence of such a seta in e.g. *Eutrombicula* or *Odontacarus*. Solenoidales (=spinales) are present on the femora of larval *Nothrotrombidium*, family Trombellidae (Southcott 1987a), a family which Welbourn (1991) includes in his Trombiculoidea. We may therefore also exclude *Yurebilla* from the Trombiculoidea.

There appears little point in going through Welbourn's (1984) list of 41 characters in detail, as in 1991 he modified it by reducing the list to 19 characters of larvae and six of adults. In this all Trombidoidea were placed in four superfamilies. Accepting this revised classification, *Yurebilla* may be excluded from the Tanaupodoidea and Chyzerioidea (these separations could be supplemented with other characters), as well as from the Trombiculoidea.

Yurebilla clearly belongs to the Trombidoidea, even as used in the restricted sense of Welbourn

(1991), where it is divided into four families. In his earlier cladistic analysis Welbourn (1984) had given as major distinguishing characters 'Apomorphies 45 & 55' for the Trombidiinae and 'Apomorphy 24' for the Microtrombidiinae. Apomorphy 45 is the absence of a 'Distal eupathid (paraxial) on the tarsus of leg I', while the plesiomorphic state is its presence. In *Yurebilla* no such seta is present so that it comes within the 'Microtrombidiinae' of Welbourn (1984). Against this is the other criterion for Welbourn's (1984) 'Trombidiinae', of 'plesiomorphy number 24', i.e. four setae on genu II & III (the apomorphic state being of two setae). In 1991 Welbourn defined his 'Plesiomorphy 10' as being of more than four setae on genu II & III, and 'Apomorphy 10b' as of less than four setae for the Trombidoidea, neither of which applies in *Yurebilla*. Another criterion for Microtrombidiinae is 'Plesiomorphy 55', i.e. of one seta on coxa II, which applies in *Yurebilla* (also listed as 'Apomorphy 54' for the 'Podothrombiini'). In 1991, however, Welbourn included eight subfamilies in the Trombidoidea, including Trombidiinae, Allothrombiinae, Podothrombiinae, Microtrombidiinae and Eutrombidiinae.

One could go through the list of apomorphies and plesiomorphies given by Welbourn in his Figure 1 and Table 1 of 1984, finding characters possessed by *Yurebilla* in various subgroups of the 'Trombidiinae' and the 'Microtrombidiinae', but no set of characters which defines its position uniquely. Apart from the confusion in characters 54 & 55, it may be pointed out that Welbourn's Table 1 contains other errors, e.g. in characters 77 & 78, which disagree with each other, and characters 97-99, which repeat those of characters 49-51.

Despite *Yurebilla* (and Yurebillidae) not matching any of the criteria for family grouping in either of Welbourn's cladistic essays, I believe that it has most resemblances to the Allothrombiidae (Allothrombiinae), and regard it as nearest to that group.

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TRADITIONAL MATERIAL CULTURE OF THE KUKU-YALANJI OF BLOOMFIELD RIVER, NORTH QUEENSLAND

CHRISTOPHER ANDERSON

Summary

This paper describes the material culture of Kuku-Yalanji speaking Aboriginal people in the rainforest regions around the Bloomfield River in south-east Cape York Peninsula, Queensland. The primary emphasis is on 'traditional' material culture, as it was around 1880 before significant European activity began in the area. However, at the end of the paper I deal briefly with some of the changes which have occurred since then and describe Kuku-Yalanji material culture as it was during a period of my fieldwork in the late 1970s.

TRADITIONAL MATERIAL CULTURE OF THE KUKU-YALANJI OF BLOOMFIELD RIVER, NORTH QUEENSLAND

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This paper describes the material culture of Kuku-Yalanji speaking Aboriginal people in the rainforest regions around the Bloomfield River in south-east Cape York Peninsula, Queensland. The primary emphasis is on 'traditional' material culture, as it was around 1880 before significant European activity began in the area. However, at the end of the paper I deal briefly with some of the changes which have occurred since then and describe Kuku-Yalanji material culture as it was during a period of my fieldwork in the late 1970s.

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The Bloomfield River area is at the northern tip of the band of tropical rain forest that stretches along the coast of north-eastern Queensland from Cardwell to Cooktown. Coastal south-east Cape York Peninsula is a region of high ecological diversity and one with a host of impressive physiographic features. The landscape is dominated by steep-sided valleys, fast-flowing creeks, high thundering waterfalls, huge granite formations and dense rainforest-clothed mountains. The coastline contains some of the largest relatively undisturbed tropical lowland rainforest left in Australia. Near the mouth of the Bloomfield, a narrow coastal woodland plain and a large swamp area separate the mountains from the fine, sandy beach and Weary Bay. The Bloomfield valley is bounded to the north by a series of mountain ranges extending from Mt Boolbun east to Mt Romeo and Mt Hartley. These ranges separate the Bloomfield River from the Normanby and Annan basins, while in the south-west the McDowall Range separates the Bloomfield from the Daintree River. The densely clad coastal range from Thornton Peak to Mt Neville extends up to 1 400 metres in places and forms the south-eastern boundary of the Bloomfield valley. The mountains in the range are also the sources of the Bloomfield River itself. Above the Bloomfield Falls near the Wujalwujal Aboriginal Community, the river is known as Roaring Meg Creek. Roaring Meg begins in the high rocky peaks of Mt Peter Botte and flows north-west, then east in a large arc, past China Camp towards Bloomfield. The creek is characterised by huge granite boulder banks, a

series of deep pools and waterfalls beginning west of Mt Peter Botte and culminating in the spectacular Meg Falls. There are five major creek systems that make up the Bloomfield drainage area. The Bloomfield River is tidal for the seven kilometres up to the first waterfall.

In the Bloomfield basin there is a basic division between closed forest and open sclerophyll forest and woodland. The closed vine forest is found primarily at the higher altitudes on both sides of the Bloomfield valley, except for some extensive gallery forests in the major creeks emptying into the Bloomfield River. A channel of open woodland forest some eight to ten kilometres wide follows the course of the Bloomfield River/Roaring Meg Creek from the coast up to China Camp and over to the Great Dividing Range. The Bloomfield coastline includes several prominent ecozones: vine forests on steep slopes down to the ocean's edge, the beach ridges at Plantation, Kangkiji and Cowie Beaches, areas of saline littoral zone in from Plantation Beach and the mangrove areas at the mouth and on the several islands in the Bloomfield River.

Environmental changes since 1880 in the Bloomfield region due to European activities have been localised and relatively minimal. Selective logging has occurred and the riverine flatlands and the coastal plain in from Weary Bay have been partially cleared for small-scale agriculture. Most of the European enterprises here have been unsuccessful due to labour problems and difficulties in getting products to market. European population levels were always, as a consequence, quite low. The one relatively

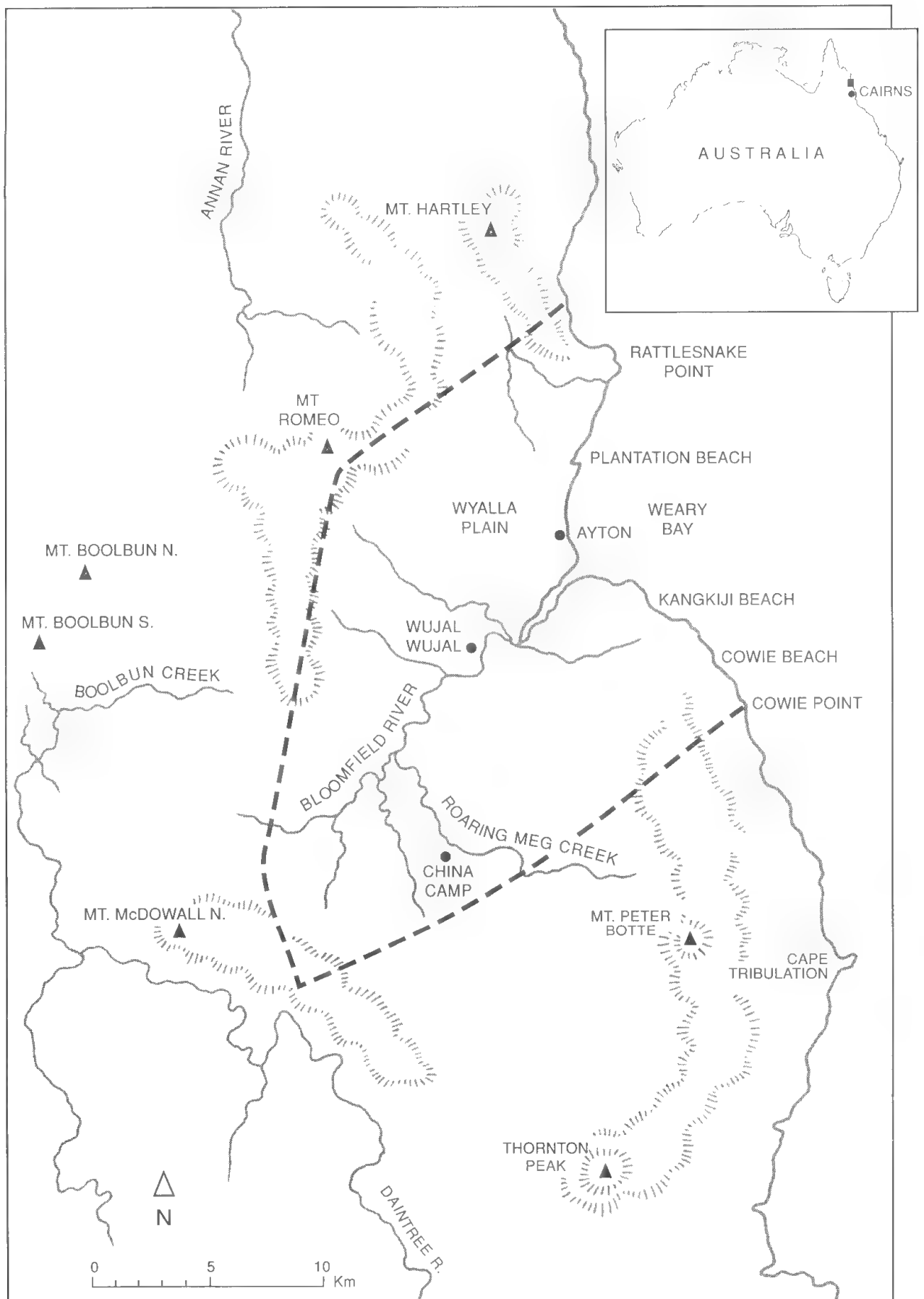


FIGURE 1. Kuku-Yalanji territory, Bloomfield River, North Queensland.

successful industry was tin-mining. Between about 1890 and 1920 there were several large scale tin operations at China Camp and in the high country near Mt Peter Botte. The major environmental effects of this activity were in its local clearing and shifting of tonnes of earth, the destruction and alteration of stream courses, and the use of local timber and firewood (see Anderson 1983).

A total of 224 Aboriginal people were reported for the Bloomfield area in 1886 (Hodgkinson 1886); in 1957 this number had reduced to 133 (Hartwig 1958). In the period of my major fieldwork in the late 1970s and early 1980s, most Kuku-Yalanji lived at the Wujalwujal settlement, then a Lutheran Church-run mission on the Bloomfield River (260 people in 1980—Anderson 1982). A few Kuku-Yalanji people also lived in Daintree, Mossman and Cooktown. Figure 1 shows the area occupied and used by the Kuku-Yalanji until their centralisation at the mission in the late 1960s. It also shows the permanent camps which existed on the Bloomfield until the mission began and which were used on an regular basis in the late 1970s.

I use the term 'Kuku-Yalanji' to refer to the people who lived on the coast between Rattlesnake Point and Cowie Point, and along the Bloomfield River and its tributaries west to the Great Dividing Range (see Figure 1). My term is thus equivalent to Roth's (1910) 'Koko-balja', McConnel's (1939-1940) 'Koko-yanyu' and 'Koko-yalunyu' and Tindale's (1974) 'Jungkurara'. Roth's term is actually the name for the Kuku-Nyungkul-speaking people of the Annan River to the north of Bloomfield. McConnel's terms are ones which literally mean 'language in which the demonstrative pronoun is 'yanyu/yalunyu' in the coastal and inland dialects respectively. Tindale's term is a clan name for a group associated with the Butcher's Hill-Lakeland Downs area 100km to the north west of Bloomfield. Roth (1910) describes the Butcher's Hill tribe as being called 'Koko-yerlan-tchi'; whereas Tindale (1974) says 'Koko-jelandji' was the tribe associated with the upper Palmer River area.

These and other sources describing the tribes of south-east Cape York Peninsula often confuse language names with clan and larger group names. Aboriginal people in the Bloomfield area had no formal, overall ('tribal') name for themselves, only names as members of this or that clan. Further, their language had no name as such either, other than descriptive labels such as those

applied by McConnel. At least by the time of Roth's first visits in 1898, they had become known by the English label, the 'Bloomfield River Aborigines'. Although there is no equivalent term in the Bloomfield language for such a term, it does seem to have been an isolable cultural unit and can be opposed to other similar ones in the area, eg. 'Annan River group', 'Daintree River people', etc.

Confusion with respect to names in this area stems from two other sources. Firstly, the names given above by Roth and Tindale for groups to the west and north-west of Bloomfield, were actual tribal and language names, at least according to Aborigines from that region in the late 1970s (Brady *et al* 1980; Anderson & Mitchell 1981). Secondly, the Bloomfield Aborigines were part of a large, linguistically homogeneous bloc, extending from just south of Cooktown, west over to the Middle Palmer River, south to Chillagoe and east to Mossman on the coast. Languages spoken in this area, including the Bloomfield ones, Muluriji, Wagaman, Jangun and Kuku-Nyungkul, are all dialects of the same language. There were also cultural similarities between groups in this area. However, I reserve the term 'Kuku-Yalanji' exclusively for the nineteen or so clans that occupied the immediate Bloomfield River valley. I use the term because it is one used in the 1990s by this group sometimes to refer to themselves. It is one that has also gained some usage in the literature (Patz 1982; Hershberger & Hershberger 1982).

Kuku-Yalanji material culture is of interest for a number of reasons. Firstly, the area's topography brings rainforest, riverine and coastal environments into close proximity. This meant that Kuku-Yalanji were able to exploit a range of resources over short distances for subsistence and for manufacture of material culture items. This in turn led to substantial camps of a semi-permanent nature. Under such circumstances certain aspects of material culture, shelter for example, were elaborated. Secondly, Bloomfield as the northern boundary of the coastal rainforest zone in north Queensland, may also have been the limit of material culture associated with that environment elsewhere. A full description of Kuku-Yalanji material culture would provide a basis for comparison with other rainforest cultures along these lines.

Thirdly, reconstruction of pre-1880 Kuku-Yalanji seasonal rounds and movement overall, demonstrate that travel occurred over a very limited area, especially for coastal and riverine

peoples. This isolation is reflected in several unique material culture items and subsistence techniques, including curvilinear lath spear throwers and the use of boiling in cooking. Fourthly, the notion of personal property with respect to material culture items and resources seems to have been particularly well developed at Bloomfield. Finally, while the overall repertoire of 'traditional' material culture was considerably reduced by the late 1970s, this did not reflect a drastic transformation of the Kuku-Yalanji economy. All major traditional economic activities continued to be undertaken, using many traditional and slightly modified tools and implements. These activities were also carried out using many items of wholly European origin. Overall, there was significant maintenance by Kuku-Yalanji of knowledge about traditional material culture and, as well, continuities in the usage of items themselves into the late 1970s.¹

Kuku-Yalanji settlement patterns and general resource use

An important distinction made in Kuku-Yalanji culture was that between the environments, resources and people associated with the sea and those associated with inland areas. The range of potentially exploitable environments in the Bloomfield coastal region was very great. Significant ones for coastal Kuku-Yalanji were the marine reefs and shallow water areas, islands and coral bays, beaches, freshwater and tidal creeks, mangroves and swamps, littoral thickets, lowland rainforest and open woodland forest. Each of these environments provided different sets of resources which were exploited on a permanent or seasonal basis. About every four to five kilometres along the coast near Bloomfield, nestled between the areas of rocky, steep and uninhabitable shoreline, are small bays and coves with white sandy beaches with one or two freshwater creeks emptying into them. These beaches were the focal points of residence and economic life for coastal Kuku-Yalanji. During both the wet and dry seasons, camps containing permanently maintained shelters were located on these beaches.² Aboriginal movement was primarily north and south between these permanent camps with seasonal forays inland up onto the coastal ranges for wallaby, yams and tubers, and wild honey, and to freshwater streams for eelfish and freshwater tortoise. The beach and tidal zones also provided abundant fish and shellfish.

In the inland areas around Bloomfield, three types of environment were habitually exploited: upper montane and riverine rainforest, open eucalypt and woodland forests and the freshwater creek systems. The latter were undoubtedly the focal points of economic life for inlanders, where good sandy campsites, shade and proximity to freshwater year-round could be found. Dry season camps were in the sandy beds of the smaller dry creeks or on the sandy terraces above the running creeks. The wet season camps were generally on the ridges between creek gullies, well above flood level, but not too far from water supplies. The pattern of movement in the inland areas was one of short distance shifts within a series of major camps along the creeks. In the dry, the smaller nuclear family-based groups would move out away from the main camping areas and set up temporary 'branch' camps in order to exploit non-seasonal opportunistic resources such as eelfish, tortoises, wallabies and goannas. In the wet, the tendency was to contract into larger more permanent camps. Large camps with up to 100 people also existed in the dry during the harvesting and preparation of seasonal, bulk-supply resources such as cycad nuts.

Kuku-Yalanji subsistence activities and material culture

In this section I describe Kuku-Yalanji material culture within the context of three major categories of subsistence activity. The first of these is hunting. Kuku-Yalanji hunting on land was essentially a solitary affair, with at most two men going out for one to two days. The exception was the large-scale wallaby drives undertaken in the dry season. These involved both young and old men, and occasionally women. Fires were carefully lit to create a 'wall' of fire going in one direction with only a few openings. Young people, starting within a forested area, walked in a long line beating the bush and shouting. This drove kangaroos, wallabies and other smaller animals towards the gaps in the fire, where the older men waited with spears (see Le Souef 1894: 13; Hodgkinson 1886: 11; and Roth 1901: 29). Apart from kangaroos and wallabies, the major meat-resource animals which were hunted included small mammals, reptiles, birds and cassowaries. The Bennett's tree-climbing kangaroo, *Dendrolagus bennettianus* (only found in this area), was tracked by sight or with the use of dogs

TABLE 1. Kuku-Yalanji spears

<i>Kuku-Yalanji Term</i>	<i>Purpose</i>	<i>No. of Prongs</i>	<i>Point</i>	<i>Handle</i>
<i>jindal</i>	hunting	3	wood (<i>Acacia</i> sp)	<i>Normanbya normanbyi</i>
<i>wurrbuy</i>	hunting	1	wood (<i>Acacia</i> sp)/ bone	<i>Xanthorrhoea arborea</i> proximal and <i>Acacia holocarpa</i> distal
<i>murrangkal</i>	hunting	1	wood (<i>Acacia</i> sp)/ stringray barb	<i>N. normanbyi</i>
<i>yingkan</i>	hunting	1	quartz pieces	<i>N. normanbyi</i>
<i>bukul-bukul</i>	hunting	1	wood w/stingray barb	Reed or bamboo proximal and <i>N. normanbyi</i> distal
<i>duwar</i>	hunting	1	wood <i>N. normanbyi</i>	Reed proximal and <i>N. normanbyi</i> distal
<i>yinba</i>	fishing	3-4	wood (<i>Acacia</i> sp)	<i>N. normanbyi</i>
<i>yirrmba</i>	fishing	4-7	wood (<i>Acacia</i> sp)/ bone	<i>Xanthorrhoea arborea</i> or bamboo
<i>dikarra</i>	fighting	3-5	stingray (pointed forwards)	<i>Xanthorrhoea arborea</i> proximal and <i>N. normanbyi</i> or <i>Acacia</i> distal
<i>kuyan</i>	fighting	1	quartz pieces	<i>N. normanbyi</i>
<i>dajal</i>	fighting/ hunting	1	stingray (pointed backwards)	<i>Xanthorrhoea arborea</i> proximal and <i>N. normanbyi</i> or <i>Acacia</i> distal
<i>bandi</i>	fighting	1	wood (<i>N. normanbyi</i>)	<i>N. normanbyi</i>

(see Le Souef 1894: 13). Other kangaroos and wallabies were stalked from down wind at times and places where they were known to graze, rest or come for water.

Twelve varieties of spears, including hunting ones, were used on the Bloomfield. These were classified by Kuku-Yalanji according to the number of prongs, the nature of the prongs, whether or not a barb or stone tip was present and what the spear handle was made of. Kuku-Yalanji spears are shown in Table 1.

These were nominal categories in most cases. Most spears could be used for any purpose if necessary. Examples of the single and multiple-pronged, barbed and unbarbed spears are in the collections of the Queensland Museum and the Australian Museum (except that the multiple-pronged, non-barbed spears sometimes have wire prongs). These vary in length from 2 300 mm to 2 915 mm. Le Souef (1894: 27) noted that the Bloomfield spears were up to 9'6" (2 900 mm) in length. A specimen of the quartz-tipped spear from Bloomfield is in the Roth collection of the Australian Museum (Kahn 1993: 151-2). Roth (1909: 193) describes how the quartz flakes were attached to the spear's end. For the wooden-pointed spears, Cooktown ironwood (*Erythrophloeum chlorostayches*) was sometimes

used as the point and distal end instead of the black palm (*Normanbya normanbyi*). In either case they were fire hardened after sharpening. The stingray barbs and the multiple-prongs were held in place by wallaby sinew and resins made from *Canarium australasicum*, *E. chlorostayches* or grasstree *Xanthorrhoea johnsonii* (see Kahn 1993: 149; Idriess 1934: 145; Le Souef 1894: 27, and Roth 1904: 11, 1909: 192-193).

For hunting, a linear or ovate lath spear thrower of *E. chlorostayches* was used. These spear throwers (termed, in Kuku-Yalanji, *milbayarr*) were very plain, usually with no shell attachment or handle. They varied in length from 0.9 m-1 m, and were from 60 mm-90 mm wide, according to the specimens in the Queensland and Australian Museums and the ones made at Bloomfield today. There are numerous scarred trees in the Bloomfield area where wood for these spear throwers has been cut out.

The other major type of hunting, at least on the coast, was for marine turtle (primarily *Chelonia mydas*). Turtle hunting was a wholly male domain and it took at least two and generally three men to conduct a hunt. One or two were needed to paddle the canoe and watch for turtles, while the other man stood on the prow of the boat with harpoon in hand and guided the boat with hand signals

depending on turtle movements. When a good-sized turtle was sighted, the prow man let fly with the harpoon, one hand pushing the end of his whole body weight behind it. This was followed, usually, by the man diving into the water, guided by the path of the rope, then diving underwater to turn over the turtle—with the harpoon point in his neck or tail. Man and turtle would then float to the top and the turtle would be hauled into the canoe.

The harpoon apparatus was made up of a handle up to three metres long made from the mangrove *Rhizophora apiculata*; a harpoon point which was a sharpened and fire-hardened point some 10 cm–15 cm long made from *Acacia crassicarpa* or sometimes *Erythrophloeum chlorostayches*; and a connecting rope made either from the smashed and twisted bark of *Sterculia quadrifida* or of *Hibiscus tiliaceus*. The point was not barbed and thus great skill was needed in throwing the harpoon so that it went into the softer portions of the turtle. The point was stuffed into the hollowed-out end of the handle and kept there by a ring-plug of gum (usually *Canarium australasicum*). This ring also acted to keep the rope attached to the point as the harpoon handle came out on impact and floated to the surface. Apart from being attached to the point, the rope was run through a hole in the flattened

and bored out end of the handle and from there it was coiled up in the bottom of the boat's prow.

The boats used were outrigger canoes with a single outrigger on the starboard side (see Figure 2). A variety of timbers were used in the construction of the dug-out portion, but *Aleurites molucanna*, *Toona australia* and a 'cotton tree' (probably *Bombax malabaricum*) seem to have been most favoured on the Bloomfield coast. The trees were cut down with stone axes, and the inside burned out and scraped clean with adzes. The outrigger was attached with lawyer-vine. The canoes were poled in shallow water and paddled in deeper water. Paddles were made from *Xylocarpus granatum*. Bailer shells were used to keep excess water out. The canoes were up to seven metres in length and could carry six to seven people or two men and two large turtles. P. P. King, during his navigation of the east coast of Queensland in 1819 and in 1821, found several of these canoes at Bloomfield. Full descriptions are in his journal (King 1827, Vol. 1: 208–209; Vol. 2: 14). Hershberger & Hershberger (1982: 106) and Oates and Oates (1964: 110) state that the Kuku-Yalanji term *mararr*, which in the 1970s was used to refer to cloth, had originally meant a sail made of plaited palm leaves. I have no other evidence of the use of sails on the canoes.

The next category of subsistence activity I want



FIGURE 2. Kuku-Yalanji people in outrigger canoes on the Bloomfield River near the mouth of Thompson Creek, 1904. Photograph: A. A. White, John Oxley Library Collection.

to examine is fishing. Fish was one of the most important components of the Kuku-Yalanji diet, especially on the coast. This resource was available at any time, to be exploited opportunistically by the Kuku-Yalanji whose knowledge of fish behaviour and habits enabled them to do so easily. There were three main ways of obtaining fish. The first was by spearing. This was normally men's work and it was done out on the reef at low tide, from the edges of a creek bank, in the water or while standing on an overhanging branch. In freshwater creeks and waterholes, eelfish were sometimes speared from underwater. 'Night-fishing' also occurred. This was done on the tidal estuaries from a canoe at night. One person sat at the front of the boat holding aloft a burning paperbark torch. As the fish were attracted to the light, another person would spear them. One of the most important species of fish and one which could be obtained only by spearing was mullet. In the late dry, shoals of mullet, particularly *Mugil cephalus* and *Valamugil seheli*, came into the creeks and up the river. At other times rock cod, coral cod, red emperor, black-tip shark and stingrays were commonly speared. The latter species was important not only as a meat source, but for the supply of spear barbs. It is significant, too, that the spearing of stingray was surrounded by restrictions. Only adult men could obtain it, and even then never in the presence of, or with the knowledge of their wives' brothers (actual or classificatory).

Multi-pronged spears were normally used, the most common being the *yirrmba* (see Table 1),

with a grasstree or bamboo handle and a hardwood or bone point. A special spear thrower was used for fishing, and as it is unique to Bloomfield it is worthy of a full description. The Kuku-Yalanji fishing spear thrower, known as a *balur*, was a curvilinear lath 650 mm–800 mm in length and 50 mm–70 mm wide. There are 14 specimens in the Queensland Museum collection and a similar number in the Australian Museum. Descriptions of the spear throwers are given by Kahn (1993: 152–3), Le Souef (1894: 27) and Roth (1909: 199). Roth states:

The ballur is employed for spearing fish or birds with, especially anything at very close quarters. It is comparatively short, made of a light timber, is haftless, and generally decorated with red and white pigment at its distal extremity. It is thrown in a manner different from all other woomeras, in that the blade rests in the fork between the first finger and the thumb, instead of, as in the ordinary style, between the first and second fingers.

The timber generally used for these spear throwers was *Argyrodendron* sp (Robins 1984). From my observations of Kuku-Yalanji use of the spear throwers at Bloomfield in the late 1970s, the peg at the end for holding the spear was varied in length and angle according to distance and the personal requirements of the thrower (see Figure 3).

The second method of fishing was with a hook and line. Spear fishing could only be done in relatively clear water. Fishing with hook and line on the other hand, could be done in the river and estuarine creeks year-round even when the water



FIGURE 3. John Walker holding a *balur* (spear thrower) on the Bloomfield River, 1978. Photograph: C. Anderson.

was muddy. The line was made from the smashed, twisted and twined bark of *Hibiscus tiliaceus*. The hooks used in salt water were shell-hooks made probably from pearl shell (*Perna Cumingii*). Kuku-Yalanji in the late 1970s had no knowledge of how the hooks were made and none existed at Bloomfield then. Rowan (1912: 110) found one on the banks of the Bloomfield River in 1892; Roth (1904: 33) describes them generally for south east Cape York Peninsula. Just south of Bloomfield in 1821 in a deserted coastal camp, King found 'a fishing rod, and a line five or six fathoms long [nine to eleven metres], furnished with a hook made from a shell' (King 1827, Vol.2: 14).

Lines were held by hand or tied to a stick set into the sand or the bank. Bait could consist of pieces of less preferred fish (eg. a small grunter or shark), small crab, frogs or small shellfish. The most common fish species taken by hook and line were the various species of bream, trevally, mangrove jack, sea perch and barramundi.

In freshwater creeks and waterholes, lines were used for turtle, eelfish, catfish and perch. Here the lines were made from the bark of *Sterculia quadrifolia* and the hooks from the thorn of the lawyer cane *Calamus australia* (see Idriess 1934: 185). Bait was generally grubs, small freshwater prawns or small frogs. Both on the coast and inland, line-fishing was seen as primarily a woman's task, but men did it occasionally.

The third method of obtaining fish was by use of plant stupeficients. This was a common technique in the inland areas in the late dry season as some of the smaller creeks dried and became a series of isolated waterholes. Several trees were used as sources for these fish 'poisons'. With *Erythrophleum chlorostachys*, the bark and leaves were smashed together under water; with *Barringtonia asiatica*, the seeds were mashed up together with a grass sponge which was then shaken and swirled under water; while with *B. racemosa*, the stems were used in this manner. These poisons stunned or blinded the fish and they then floated to the surface where they could be collected. The divers had to close their eyes very tightly as they worked and be careful not to swim through any of the substance in the water. The waterhole was then unusable until after a storm and flood renewed the water.

The third and final subsistence category to examine is gathering. One important gathered seasonal resource was fruit. At least fifty major species were considered desirable by Kuku-Yalanji. Most of these ripen in the period May to

August, and most are found either in rainforest, on its margins or within gallery forests along the major creeks.

Important species included quandong, Burdekin plum, wild almond and several species of *Eugenia* and *Ficus*. Collection of the fruit was often as an adjunct to some other production task, for example men while hunting, or women while fishing. Long sticks were often used to knock down fruit from the taller trees. Bark troughs or dilly bags were used for carrying of the fruit. Some fruit such as certain *Ficus* species and the quandong could be kept for several weeks after being dried in the sun, while others such as the Burdekin plums could be force-ripened by burying them in the ground in a dilly bag and left for up to a week.

Nuts were another gathered resource and around ten important species were utilised on the Bloomfield. I will describe later the material culture items used for preparation of these nuts. Tubers, bulbs and wild yams were the cornerstone of the Kuku-Yalanji diet, especially in the inland area. Most of these were available from the mid-dry season until November or so, but others were available in the wet season. Important species were *Tacca pinnatifida*, *Typhonium brownii* and four varieties of *Dioscorea sativa*. One of the latter, *Dioscorea sativa*, var. *rotunda* or 'hairy yam', was probably the most important vegetable food item in the Kuku-Yalanji diet and was the mainstay of meals for up to five months. Both men and women could dig the yam, but if dug by men then women could not eat them. In practice it was women who supplied the bulk of this resource (see Hodgkinson 1886: 10). These yams grew in the sandy-soiled, open forest country, on the edges of swamps and on the river and creek banks. They were dug out with one of the most important subsistence tools at Bloomfield, the so-called digging stick. The author Ion Idriess, who lived at Bloomfield for several years before the First World War, described this item:

Like all their simple tools, [the stick] has a surprising number of purposes... as a digging stick for uprooting vegetable foods, as a prodder and level for forcing small animals (snakes, lizards, birds) from log or burrow or tunnel in river bank, as a 'border' for water. Primarily, though, it is a digger of yams... About five feet long [1.5 m], a heavy, well-seasoned staff of hardwood, it tapers at one end to a point, and this makes a very efficient tool... (Idriess 1980 [1959]: 251; see also Roth 1904: 24).

Once dug, the hairy yam, as with many of the vegetable foods in the Kuku-Yalanji diet, needed extensive processing. This is described below.

Apart from fruit and vegetables, a host of other resources were gathered in this area: shellfish, terrestrial snails, insects such as green ants and their eggs, scrub fowl and bush turkey eggs, mangrove worms and so on. None of these activities required any special material culture items nor any special process. Two significant resources requiring special tools were tree grubs and wild honey or 'sugarbag'. In both cases trees had to be either cut down or chopped up. The grubs were the larvae or pupae stages of moths which live in rotten or fallen trees. The large ones, particularly those found in the candlenut tree, were relished food items; the smaller ones, and ones from certain 'poison' trees, were used as fishing bait.

Throughout the dry season sugarbag was an important and highly desired resource. Nine species of indigenous bee found in south-east Cape York Peninsula were recognised by Kuku-Yalanji as producing honey. Sugarbag was located either by chance sighting of bees going into and out of a hole in a tree or by following bees back to the nest. Idriess (1980 [1959]: 246–247) describes how Aborigines at China Camp attached a 'streamer' of bush cotton to a bee's body. This streamer made a loud hum as the bee flew and it was easy to then track it to the hive. During the late dry, the bases of trees known to be favoured by the bees were examined for bee dung, and also tapped for hollowness. If located and if the nests were low enough, the hole was simply made bigger and the comb extracted, sometimes with the use of a hooked swab made of lawyer cane. The honey was then placed in a bark container. When the nests were high in the tree, grass ropes were made for climbing.

Alternatively, in some trees steps were cut on each side for easier climbing. I noted such steps on many trees in the Bloomfield area in the late 1970s. Sometimes the entire tree was chopped down. Le Souef (1894: 27) notes: 'It is surprising to see how hard the [Bloomfield] blacks work in cutting down a big tree to get a hive, otherwise out of reach, as they are very fond of honey'.

Hafted stone axes were used to obtain both the grubs and the bee hives. The celts were tied onto a handle made of a portion of large lawyer cane and secured there by bark fibre or wallaby sinew and a gum mixture of beeswax mixed with resin from *Canarium australasicum*. The resulting axe was reported to me by Kuku-Yalanji in the late 1970s to be able to cut down softwood trees up to a metre in diameter and hardwood trees up to about 40 cm. With hardwood trees, a downward stroke

chop was used (as opposed to a horizontal chop) which progressively split the tree layers. Examples are in the Australian Museum collection (Kahn 1993: 135–136).³

Camps and domestic life

As I noted earlier the focal points of Kuku-Yalanji residence were the sand beaches on the coast and near the main freshwater creek systems inland. At both types of site, shelters were of two basic types: temporary shades and windbreaks; and permanent dome-like huts. For much of the dry season Kuku-Yalanji people used no form of shelter at all, preferring instead to sleep close to fires out in the open campsite.

Windbreaks, made from large branches of any available trees, were set up sometimes for privacy between sections of camps, or to protect the site from strong winds, particularly on the coast. The dome huts were built at the inland camps mainly during the wet season, whereas on the coast they appear to have been maintained year-round, and only refurbished when necessary. The basic form was the same for coastal and inland huts (see Figure 4). Le Souef provides a first-hand description:

The natives made our humpy of fan palm leaves—first a framework was formed of light saplings bent over and fastened together, and then the large leaves of the palm laid on; these made a rain proof dwelling, and all those of the natives in this district were made in the same way, but covered with whatever they could get nearest at hand, either the leaves of the Fan Palm, Lawyer Palms, grass or bark. The size depended on the number of inmates; but the natives here make their dwellings considerably larger than [elsewhere in north Queensland]. Le Souef (1896: 154)⁴

Roth (1910b: 59–60) also gives a similar description for south-east Cape York Peninsula structures in general. He notes that at Bloomfield the leaf thatching was put on from the top down, with logs and bark sometimes placed on top to act as weights. Also he states that a fire was normally built inside the huts and that they sometimes had one or more entrances.

Thus on the Bloomfield River, a man with one wife and a small family will occupy a hut with a single entrance; if he has one old wife, and other wives and children, a larger habitation will be used, the old woman having a separate entrance and separate fire to herself. (Roth *ibid*).

Kuku-Yalanji people during the late 1970s informed me that young saplings of the Burdekin plum tree (*Pleiogynium timorense*) were particularly favoured for hut construction, but that any flexible saplings would suffice. For the inland huts, if palm leaves were unavailable, bark from the 'Messmate' tree, *Eucalyptus tetrodonta*, was used. Sheets were cut and peeled off the trees when the sap had arisen after the first storms in December. These sheets were pounded with stones and smoked with the fire until flat. McConnel (1931: 9–10) notes that on the Bloomfield, house building was normally the job of the woman.

Fire was a central part of domestic camp life. It was made by means of a fire-stick by men (although sometimes by women at Bloomfield; see Roth 1904: 10). This fire-stick had two components: a thin wand of about 30 cm and a flat, wider piece of wood about half this length.⁵ The wand was twirled vertically with the palms of the hands while the base of the wand was set in a small notch in the flat piece, which lay flat on the ground. The friction created smouldering ash which caught alight with the addition of dry grass

and wood particles. Dry grasstree sticks could also be used.

Collecting firewood was usually women's work and different woods were used for different purposes. If conditions were rainy and damp, wood from the 'kerosene tree' (*Halfordia scleroxyla*) made an excellent fire starter. Inner portions of bark from the forest paper bark tree (*Melaleuca leucadendron*) could also be used for this purpose. Dead branches from the grey boxwood (*Eucalyptus tessellaris*) made the best cooking wood: it is very hard, but splits easily and burns slowly and intensely. Some wood was very dangerous to use as firewood. For instance, a mangrove species, *Excoecaria agallocha*, produces a smoke which is said by Kuku-Yalanji to produce blindness. This is also true of the 'brown cedar', *Canarium australasicum*.

The camps were the usual sites for food preparation and consumption. Below I discuss several major Kuku-Yalanji food items, their preparation processes and necessary implements.

Preparation of cycad nuts

During the mid to late dry season, a staple food

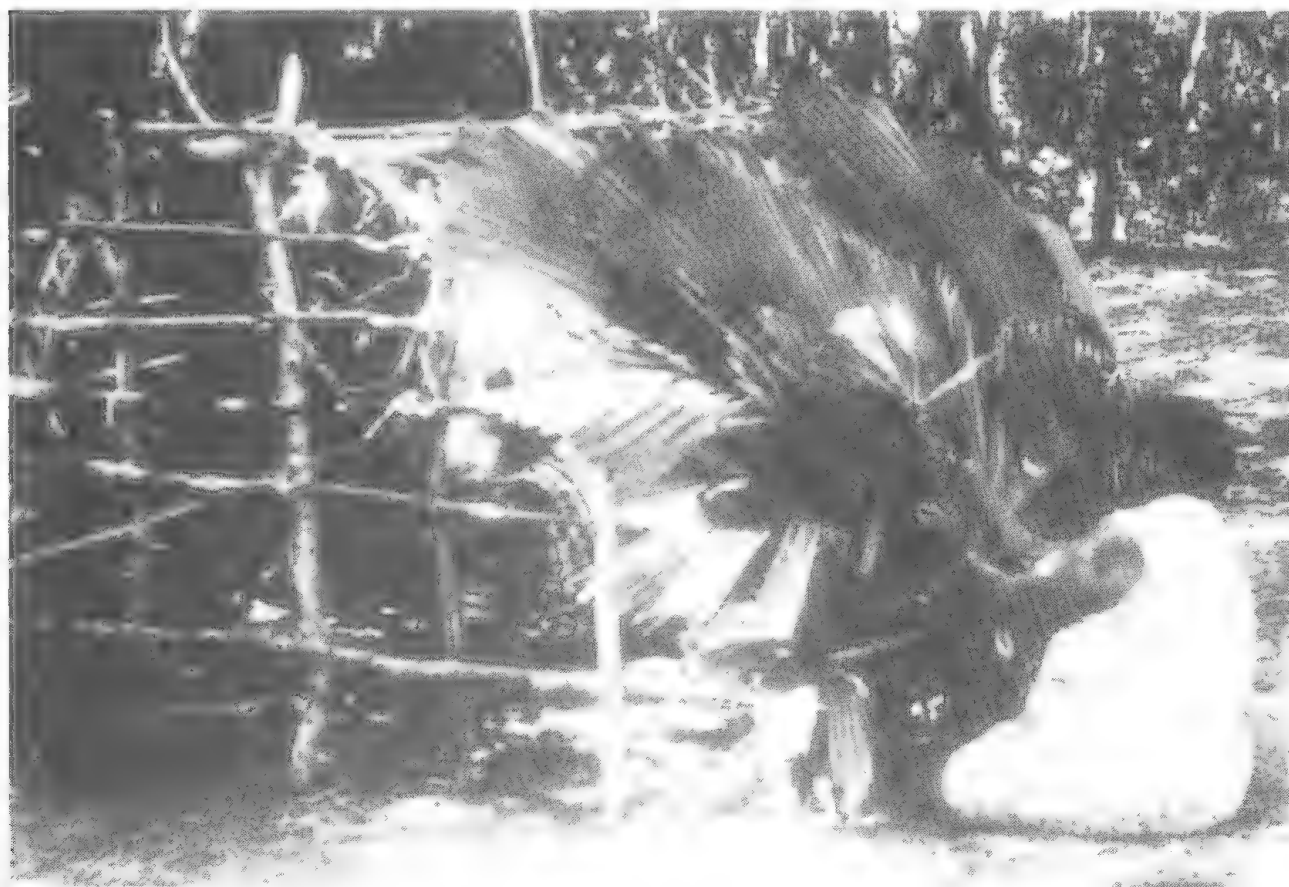


FIGURE 4. Dolly Yougie (right) and Eileen Walker (inside), making a wet-season shelter at Plantation Beach, 1982. Photograph: C. Anderson.

item was *Cycas media*. This plant grows prolifically at several locations in the Bloomfield area. When the ripened nuts fell off they were gathered and brought back to a central processing site, ideally beside a shallow, but fast-flowing section of creek. More important were the large flat rocks with small indentations in them, found adjacent to the creek. These were necessary for grinding purposes and were known in Kuku-Yalanji as *jinali*. Their locations were widely known and the sites associated with them used each year. The main grinding surface was usually on the top of a large boulder in the creek itself. Thus during the harvesting and processing time large central camps were set up at these sites.

The women did the processing, while the young men kept the camp supplied with food items such as meat and sugarbag. The first stage of the processing was the roasting of the nuts on the fire, which cracked open the soft outer shell. This was peeled off and the remaining kernel then left for several days prior to grinding. The delay was said to make for easier grinding. The kernels were then ground in the small indentations on the *jinali* using a round, fist-shaped stone. The coarse particles remaining after the initial grinding were

then separated from the flour with a small grass 'brush' for further crushing (see Figure 5). This process of grinding and separation continued until only a fine flour was left. Sometimes a closely woven dilly bag was used as a sifter. Roth provides an excellent description of the remaining processes:⁶

The flour is... put into a grass dilly-bag, which has been previously folded sideways upon itself so as to form a basin-like receptacle and placed near a stream. With the help of leaves [pandanus or wild ginger] acting as a trough, water is allowed to continue flowing into the receptacle, matters being so regulated that the water never overflows the edges. Fresh water is thus continually percolating through the Zamia flour in its dilly-bag colander, right through the night, and in the morning it is ready to be eaten. It may, however, be kept for some three or four days, up till which time it is believed to improve... (Roth 1901: 11).

Hodgkinson (1886: 8) provides a similar description. Some Kuku-Yalanji people in the late 1970s still had detailed knowledge of this process. Also, the stone implements are still *in situ* at several of the sites despite their lack of use for some thirty to forty years.



FIGURE 5. Dinah Stumpy grinding cycad nuts into flour, Ayton, ca 1962. Photograph: H. Hershberger.



FIGURE 6. Louisa Smith making a *balji* (dilly-bag) with black palm fibre strands. Wujal Wujal, 1982. Photograph: H. Hershberger.

The two dilly-bags used in the above process represent two of the three main types of bags at Bloomfield. The first bag was made from fibre strands obtained from the perfoliate bases of the leaf-petioles of the black palm, *Normanbya normanbyi* (see Figure 6). The second type of dilly-bag was made from the grasses *Xerotes multiflora* or *X. loniflora*. The palm bag was made with two continuous strands chained together and several straight basal strands, while the grass one was made with one continuous strand, in the 'hour-glass' pattern. These two bags were important items and apart from their role in various preparation processes, women used them for carrying anything (including infants). The third type of bag was a men's bag, termed a *ngunyin*, and was made from *Ficus* fibre-twine. It was said by Kuku-Yalanji to have been able to stretch big enough to carry a small wallaby. Otherwise men carried in these bags personal items such as a small stick with ironbark or other gum attached to the end, firesticks wrapped in paperbark, spare spear barbs, and medicinal or sorcery-related items⁷ (See Roth 1901b: 8,10; 1904: 28; Kahn 1993: 105–111; Idriess 1980 [1959]: 242).

Preparation of other nut species

Most of the nut species used as subsistence items required some form of preparation. The major species are shown in Table 2. The most highly desired species was the candlenut, *Aleurites moluccana*, which, in addition to being

TABLE 2. Major nut species eaten at Bloomfield and preparation requirements.

Kuku-Yalanji Name	Common English Name	Botanical Name	Roasted on fire	Baked in ashes	Sifted in dilly-bag	Pounded with stones	Leached
<i>jajikal</i>	Screw palm	<i>Pandanus spiralis</i>	No	Yes	No	Shell broken first	No
<i>babur</i>	Matchbox bean	<i>Entada scandens</i> , Benth.	No	Yes	No	Yes	Yes
<i>bilar</i>	Candlenut	<i>Aleurites moluccana</i> (Linn.) Willd.	Yes	No	No	No	No
<i>baway</i>	Moreton Bay chestnut	<i>Castanospermum australe</i> , A. Cunn	No	Yes	Yes	Yes	Yes
<i>junda</i>	Wild almond	<i>Prunua turnerana</i> (F.M. Bail) Kalkm	No	Yes	Yes	Yes	No
<i>bujabay</i>	Queensland walnut	<i>Endiandra palmerstonii</i> (F.M. Bail) C.T. White	Yes	No	Yes	Yes	Yes

eaten on their own, were added to wallaby carcasses to add flavour during cooking. On the other hand, some species such as the matchbox bean, *Entada scandens*, were not particularly relished and only eaten if nothing else was available (see Hodgkinson 1886: 4; Roth 1898b: 2). Although most species were arduous to prepare for minimal return, the advantage of nuts was that they could be gathered and kept for up to two months. In the wet season—a time of great dependence on nuts—this meant fewer trips out and away from camp during a time of heavy, continuous rain and reduced mobility due to swollen creeks and rivers.

Yam preparation

Preparation of the otherwise toxic *Dioscorea sativa*, var. *rotunda* or hairy yam also involved the use of a dilly-bag for leaching. Once dug the yams were taken to a processing site—once again, near a small, rapid creek—and clinging roots and dirt were removed from them. They were then baked in a stone oven for several hours until soft and cool. The yams were then mashed by hand in a palm-fibre dilly-bag. After the mashing process, the bag was held over a bark trough and water poured into it to allow the substance to be strained. More mashing, pouring and straining was done until only the rough fibres and skin strands were left in the bag. This residue was then thrown away. More water was added to the bark containers and they were allowed to sit for some time as the yam substance sank to the bottom. Within a short time, an oily substance appeared on top of the water. This was said to be the 'poison', and it and the water were then poured off. Fresh water was then added and the process repeated again a number of times over several hours until the water was completely free of the oil and any bitter taste gone from the yam substance. A crater-like hole about a metre across was then dug in the ground, and clean white sand placed in it. A rolled, large round leaf was put into the bottom of the hole to channel the water away. The porridge-like food was then eaten on leaf plates.⁸ Several other yam species were eaten on the Bloomfield without any need for processing other than roasting on the fire. Wild arrowroot, *Tacca pinnatifida*, and another tuber, *Typhonium brownii*, on the other hand, both needed alternate roasting and pounding between two stones in order to be edible. Several of the yams and tubers could be dug and kept without processing for two to three months into the wet season.

Cooking processes and associated implements

Many meat items, including reptiles, birds, wallabies and other marsupials were cooked straight on the fire after their bodies had been bashed with an axe to break the bones (see Le Souef 1896: 157). Larger animals such as marine turtles, cassowaries and eelfish were butchered and the meat cooked in a stone oven. Certain round rocks which were known not to crack were placed in a hot fire. Meanwhile a hole was dug near the fire. When the stones were hot, they were picked up with lawyer cane tongs and placed in the hole (see Kahn 1993: 120). The meat, along with *Eucalyptus*, *Acacia* or wild ginger leaves for flavouring, was then put into a bark trough which was placed on the rocks in the hole. Other hot rocks were put around the trough and onto the meat itself. Ti-tree bark was placed over the trough and onto the meat itself. Ti-tree bark was placed over the trough and rocks, then all was covered with sand or earth and left to cook for several hours.⁹

The bark troughs used in the above form of cooking were another important and widely used item of Kuku-Yalanji material culture. Examples are in the Australian Museum collection (see Kahn 1993: 101–102). They were made from the bark of various *Eucalyptus* species, *Curcuma australasica* or *Tristania suaveolens*. If these were not available, dry bark sheets from the palms *Archontophoenix Alexandrae* or *Normanbya normanbyi* could be used to make a temporary trough. With the normal troughs, the bark was soaked in water then bunched up at each end into a kind of 'spike'. Apart from use as a cooking utensil, the troughs were used for carrying water, honey or vegetables, for preparing various species of fruit in (mashing and mixing with water), for carrying infants in and for ferrying things across swollen creeks.

Two other cooking processes are worth mentioning. The eggs of the scrub fowl (*Megapodius freycinet*) were a major dry season protein source. They were wrapped into a 'bag' of big round leaves which had been extensively soaked in water. This bag was then buried in the ashes of a hot fire and left to roast. Boiling was also practised on the Bloomfield, in a number of ways. It was sometimes done in water-soaked bark troughs which sat directly on the fire. Kuku-Yalanji people in the 1970s informed me that an alternate method was to place red-hot rocks into water in the troughs to achieve the same result. The most widespread method of boiling, though, was in the large *Melo umbilicatus* shell (See Roth

1901a: 8; and Kahn 1993: 103–104).

Other domestic implements, games, musical instruments and raw materials

Apart from those already mentioned, a range of other domestic implements were used in the Kuku–Yalanji camp. Spoons were made from a variety of materials. The most valued ones were those made with the scoop of nautilus or melo shells. Unmodified mussel shells were used as more temporary spoons or scoops. These shells, especially *Geloina coaxans*, were also used as scrapers (to remove ashes from cooked meat, for instance), or as a cutter. Only live shells were used to make these implements as dead ones cracked unevenly when worked. Small personal knives were made from short pieces of wood with a quartz end. Leaves, especially those from palm leaves, were used as scoops, plates and water carriers. Fan palm leaves were used as 'tablecloths' and as seats and bunches of long bush grass served as mattresses on hard ground. Sheets of *Melaleuca* also sometimes served these same purposes, and additionally were used as blankets in cold weather. Dry bottlebrush stems were sometimes used as torches around camp and were said to burn for some time. Cassowary feathers were used as fly and mosquito swatters.

String games, using fibre and human hair twines, were played by adults and children. Young boys and girls played a game called *birray*, or 'March fly', in which they chased each other while buzzing like the fly. Young men held diving competitions from tree branches into the water and also held wrestling matches. Toy canoes were made from bark and palm leaves and small toy 'boomerangs' were made from pandanus leaves. Another well-documented Kuku–Yalanji game was one in which a small wheel (made of a log of softwood or the top of a zamia tree) was covered on the sides by red clay and beeswax and then decorated with parrot, pigeon or cockatoo feathers. This wheel was then rolled down a hill and spears were thrown at it. Men used normal spears and boys used toy spears made from dry grasstree stems (see Roth 1902: 18; Idriess 1980 [1959]: 199–200).¹⁰

Apart from spear throwers used as clapping sticks, the only other major musical instrument at Bloomfield was a wind instrument called a *yiki-yiki*. Le Souef obtained one at Bloomfield in 1893 and noted that it was:

a kind of rude musical instrument, a straight hollow trunk of a sapling, 9'6" long by 2 ¾" in diameter at one end and 2" at the other. It is naturally hollow,

and not done artificially; it is very seldom that trees for the purpose are found. They blow through it as one would through a fog horn, the noise being made by the blower. It is heard a good way off, and has a musical sound which at distance is very like a flute (Le Souef 1894: 27).

Roth (1902:23–24) also describes the instrument, noting that while not decorated, it often attained a very polished look from heavy use. Instruction in how to play the pipe was given to young men during initiation, but the instrument could be openly played in public.¹¹

I have already mentioned some of the materials used in manufacturing the implements for food-processing and other subsistence tasks. Gums and resins were an important resource (samples are in the Australian Museum collection, Kahn 1993: 130–131). I have noted the use of *Canarium australasicum* gum for fixing spear points and axe hafts. *C. muelleri* resin, and the gum from a forest *Causarina* species (probably *C. littoralis*), *Xanthorrhoea johnsonii* and *Grevillea striata* were also widely used. The first two were valuable for trading purposes and thus were not used freely (see below), and the latter two were said not to have very good bonding qualities. On the other hand, the gum extracted from the root of *Erythrophloeum chlorostachys*, the Cooktown ironwood, was readily available and of good quality. The outer sticky covering of the roots was scraped away¹² and gathered together on the end of a stick and then lightly heated on a fire. The substance was then pounded between two stones (which were greased with cassowary fat to avoid sticking), then roasted and pounded again until soft. It was applied to a spear or other implement with a small wooden smoothing board (also greased).

Other manufacturing items included the use of *Ficus opposita* leaves as sandpaper for smoothing spear throwers or any other wooden implement, and candlenut seed oil as a fixer for ochre.

Personal property, decoration, magic, ceremony and conflict

The notion of personal property with respect to material culture items and resources generally was a feature of Kuku–Yalanji culture at Bloomfield. The palm fibre dilly-bags and yam sticks for women and the net-bags, spear throwers and spears for men, were all considered personal items and would not normally be lent to others. The nautilus shell spoons were also very personal

items. A hole was sometimes drilled in them and they were worn around the neck (Roth 1904: 29). Animals were also apparently kept in camp as personal pets. Le Souef (1894: 16) mentions people raising baby scrub fowl; Roth (1902: 9) reports that young boys at Bloomfield had dingo pups as pets while they were being trained for hunting (see also Hodgkinson 1886). Roth states that women sometimes suckled the pups. Idriess (1934: 67); 1980 [1959]: 193) notes that cassowaries, wallabies, turtles and birds were kept as the pets of individuals at Bloomfield.¹³

Dick (MS n.d.) describes a sign system which labelled personal ownership of particular resource items. He states:

Most simple of... signs are those that denote ownership. A piece of bark knocked from a tree containing a bees' hive; a stick pushed into the mud beside a crab hole; the leaves trimmed from a stick that will eventually become a spear shaft; all will establish such a thing as personal property and will be respected as such even though the one who made the sign may be unknown.

With respect to resources in general, Roth reports an interesting item concerning personal ownership: 'The only instance known to me of women holding what might almost be called real estate is on the Bloomfield, where the patches of zamia plants (edible) are apportioned amongst the females, each woman bequeathing her lot to her daughters or other female relatives' (Roth 1906: 9). Unfortunately Kuku-Yalanji informants in the late 1970s could only tentatively confirm this and I have no other evidence of the existence of such a practice.

Decoration of the body was either through the wearing of a physical ornament or through painting or dyeing parts of the body itself. In the first case, there were numerous items worn on the head, the neck, the arms and waist. As I noted above, whole nautilus shells were worn on strings around the neck (men between their shoulders on the back and women between the breasts); Nautilus shell or pearl shell pieces were strung together to make a headband (see Kahn 1993: 116–117)¹⁴; necklaces of grass-bugles, 'pencils' of hardened beeswax, shell pieces or seeds of *Abrus precatorius* were worn. The latter seeds were also mixed with beeswax and put onto the hair, as were small clay balls mixed with bloodwood seed pods. During ceremonies and on some hunting trips, prominent Kuku-Yalanji men wore a head ornament consisting of a tuft of cockatoo top-knot feathers stuck into beeswax. The hair itself was modified: it could be cut using

the quartz knife; it could be dyed red using the fruit of *Barringtonia racemosa* or rubbed black with charcoal.

On the body, pandanus leaf armlets were worn as well as waist belts or apron-belts (examples are in the Australian Museum collection, Kahn 1993:112–113). Roth (1910c: 39) states: 'The Bloomfield River women wear a circlet of human hair or fibre rope around the waist; it is commonly met with on the older females, and those who have suffered any trouble over a recent accouchement, though in all cases it is looked upon in the light of an ornament, especially when some red colour is woven into it'.

Idriess (1980 [1959]: 243) describes wallaby sinew or plaited hair belts which were worn by men and in which they carried their stone axes. Body painting was done for some hunting trips, and on mourning, fighting, initiation and dancing occasions. Red and yellow ochres, *Grevillea* charcoal and white kaolin clay were the major sources of paint. While men were painted anywhere on their bodies, women were only painted on the faces. More permanent body decorations were obtained through scarification of the chest or arms, or by having the nasal septum pierced. Both of these were done strictly for beautification purposes. In the case of the nose, while the wound was healing, a plug of soft unfertilised banksia stalk was put into the hole and regularly twirled to keep it open. Avulsion of one of the central incisors was also practised at Bloomfield and while this (like nose-piercing) was influenced by prevailing fashion, it was more properly associated with marriage custom (see Anderson 1984).

Decoration of material culture items was minimal. Small zig-zags and other designs were carved into spear throwers to personalise them. The handles of spears were usually painted with red and white stripes, and sections of the dilly bags were sometimes dyed red with the 'bloodroot' tree, *Hoemodorum coccineum*.

At Bloomfield, there were few magic and ceremonial material culture items. Any portion of a human body (deceased or living) could be used for sorcery purposes. Especially common items included tufts of hair, teeth, fingernails, certain bones or 'fat' and these were often carried around in secret wrappings in dilly bags. Other sorcery- and magic-related implements included small quartz-crystal stones (see Kahn 1993:98) and small effigies of people made from softwood which would be burned or placed in a tree. There was also the 'roarer', a piece of wood about

150mm long which was hung from a tree with string to make the area underneath taboo. It was usually painted red with white stripes and often had a small indentation at the bottom. During initiation ceremonies a special hollow log called a *murla* was placed near the site of the ceremony to render the ground taboo. After death some bodies were placed in large bark troughs, very similar to those used domestically, except with a covering over the top. Later in the mourning process, the bones of the deceased were also sometimes carried around by relatives in smaller, pillow-like bark containers.

Kuku-Yalanji fighting spears and the materials used in their manufacture have been listed above. Several other significant material culture items were associated with conflict. Physical conflict at Bloomfield took a number of forms including: (i) generalised fights of one group against another, often in the form of an ambush; (ii) two groups 'squaring off' against each other in a formal fight; (iii) two disputing individuals taking turns to hit each other on the head with sticks; (iv) a formal 'trial by spear' of one individual against a group with a grievance against him. With the first two forms, fighting spears and the curved woomerars were used. In the third case, men used fighting sticks and women used their yam sticks. A fighting stick from Bloomfield River is in the Australian Museum collection (Kahn 1993: 140). There are several eyewitness accounts of women fighting using yam sticks (Le Souef 1897: 26–27; Idriess 1934: 120; 1980 [1959]: 251).¹⁵ In the 'trial' the defendant was given the longer, straight spear thrower and he was allowed to block or deflect the spears thrown at him.

Two other items in this domain were noted by early observers of Kuku-Yalanji culture: the so-called shields and swords. Roth describes the shield:

The Bloomfield weapon was somewhat more oblong and rectangular as compared with that of the Tully, and usually larger, such dimensions as 3 ½' [106 cm] by 1 ½' [50 cm] being not uncommon, it is however, fast falling into disuse, and even so late as 1898 was only being occasionally manufactured by some of the very old men. The Bloomfield natives called it *kun-juri* and used to paint it with varying designs (Roth 1909: 205).

A shield collected by Roth is in the Australian Museum (Kahn 1993: 141–142). Le Souef also describes a shield 3'8" (110 cm) long by 1'4" (40 cm) wide (Le Souef 1894: 27). Neither source gives any information on methods of manufacture or the woods used at Bloomfield. Both Le Souef

and Roth also mention the single-handed sword being found at Bloomfield. This was from 3'3" to 5' (108 cm – 150 cm) long and about 6" (16 cm) wide. Roth (*ibid*) notes that in 1898 only a few old men made this implement. Although older Kuku-Yalanji in the late 1970s knew of these two items and knew that they had been used at Bloomfield, no one had ever made one or seen one for at least 60 years. The swords were sometimes used as fighting sticks during the ritual head-hitting; the shields were given to individuals for blocking spears during the formal trial. There are two swords from Bloomfield in the Australian Museum collection (Kahn 1993: 158–159).

Communications, trade and introduced items

There were two primary ways of sending messages between individuals and groups. The first was the message stick. Only the oldest Kuku-Yalanji in the late 1970s had any recollection of these, and no one was able to say what types of signs and symbols were used on them. They did say that there were two types: one, a special stick for carrying bad news, especially about the death of a relative (*jarrjal*); and the other, an all-purpose stick for general messages (*kaban*).¹⁶ There are several message sticks from Bloomfield in the Australian Museum's Roth collection (Kahn 1993: 126). They were ones given to Roth or to the hospital doctor at Cooktown to inform relatives that a patient was recovering or ones given to Roth to take to Aboriginal people elsewhere to introduce him and ask that they give him this or that item of material culture.

The second method of communication was through signs left on the path or at a site. These were termed *duburan* in Kuku-Yalanji. I have already noted the signs left to denote ownership. Other signs were made of bundles of grass or sticks and placed at about eye-level along the path. These showed who went where, how many people, whether they were armed or not; others showed a turn-off on the path or indicated water or some food resource. As Dick notes, the form these messages took ranged 'from a knotted tussock of grass with the tips pointing in the desired direction, a single stem of grass woven into the branches of a shrub, a number of straws or a palm leaf tied to a tree (all with their butts as pointers), to rather complicated little devices tied to sticks pushed into the ground' (Dick ms.).

McCarthy's (1939) summary of trade in

Aboriginal Australia shows south-east Cape York Peninsula to be an important trade centre, as the source of many trading items such as pearl shell, but also in terms of the amount of trading which occurred within the area (see McCarthy *ibid*: 417–421). As no other data exist on this topic for the Bloomfield area, I shall rely, as McCarthy did, on Roth. Roth stated that in the Bloomfield River district:

The articles of home production for trade and barter were dilly-bags, spears, woomeras, edible pipe-clay (within recent years), best kind of fighting sticks, shields and swords (in the old days), several varieties of gum-cements, and red ochre. These would be bartered for stingaree-spears, shell ornaments, yellow ochre, edible pipe-clay (in the old days), shields and swords (in recent times)... There were not particular individuals to effect the exchange, each one acting on his own behalf, nor were there any restrictions as to which of their neighbours they might barter with. The principal time of barter was during the laying-season at King's Lake country [King's Plains near the Laura–Cooktown road, C.A], ie. whenever there happened to be a sufficient supply of food to attract them. There was apparently no conception of relative values, and though not a regular practice, members of the same tribe would interchange. (Roth 1910d: 17–18).

Roth also notes that apart from the King's Lake gatherings, Bloomfield district people went up as far as the Laura River district and supplied the Koko–Warra there with red ochre, white clay, and grasstree spears, and received in return, melo shells, reed spear sticks, shell necklaces, stingray spears and fishing nets (string dilly-bags).

The issue of trade raises the matter of the relationship of Kuku–Yalanji material culture with that of other groups in eastern Cape York Peninsula. A detailed consideration is beyond the scope of this paper. However, several points can be made. In many ways, Kuku–Yalanji people had a similar economy to that of other groups living in rainforest environments. This is especially so with respect to the range and type of primary resources. As a consequence, there is commonality of subsistence techniques and of some material culture items (stone-grinding of nuts, leaching techniques, hunting items, etc). On the other hand, it may be misleading to speak of 'rainforest culture', in the sense of a wholly common material culture among the Aboriginal groups who lived in the north Queensland rainforest. In many major domains of material culture Kuku–Yalanji shared more with non-rainforest, coastal and inland peoples to the north and west (at least as far north

as Princess Charlotte Bay and to the west over to the middle Palmer River area), than with the 'rainforest people' to the south. This was true of watercraft, of shelter styles and of spears and spear technology. Bloomfield people did not use cane to make baskets, although the closely related groups just to the south near Daintree did. It appears as if the drone-pipe used at Bloomfield came from the Gulf of Carpentaria region via the Laura district Aborigines (Roth 1902: 23). On the other hand, there were certain items at Bloomfield which had no relationship to the material culture of groups either to the north or south.

The most obvious example is the curvilinear lath spear thrower. Roth recounts how one of these washed up on the shore at Cape Bedford north of Cooktown. It was brought to the local missionary, 'who, never having seen one before and being anxious to know something about it, asked the local [Gugu–Yimidhirr] blacks what it was; they could not give it a name, but they told him that the person who made it must have been mad!' (Roth 1901: 199–200).

Further work comparing the material culture of the rainforest groups with those of the groups beyond the boundaries of the rainforest areas (to the north, south and west) is necessary in order to test this hypothesis.

Post-contact material culture change

I will now examine some of the changes which occurred in Kuku–Yalanji material culture in the first few decades after first contact, and then move to a brief description of it during the late 1970s.

The earliest contact items of interest for Kuku–Yalanji were primarily metal, glass and cloth. Iron was found at Bloomfield six years before any European settlers arrived. In 1873, William Hann, the first land explorer in south-east Cape York Peninsula, met a group of Aborigines at Bloomfield carrying 'iron tomahawks' (Hann 1873: 16). Later Hann found in a camp at Bloomfield 'pieces of iron, and amongst them a rod of the same metal, about three feet in length, evidently used as a yam stick' (Hann *ibid*: 20). On one occasion, during the night Aborigines on the upper Daintree stole a digging pick, a washpan and 'items for mending clothes' from Hann's supplies. The first Lutheran missionaries at Bloomfield in 1886 had constant difficulties with the Aborigines taking metal tools (Meyer 1891). Roth reports finding iron as part of many domestic implements at Bloomfield: iron wedged into a

wooden handle to make an adze for scraping out canoes (Roth 1904: 22; one of these from Bloomfield is in the Australian Museum, Kahn 1993: 133); a piece of iron or a table knife cemented into the end of a digging stick (*ibid.*: 24); the use of glass instead of quartz in fighting spears (Roth 1909: 193); the use of iron (for example, three-cornered files) for barbed turtle harpoons (Roth 1909: 76; 1904: 32).¹⁷ Several knives from Bloomfield made from shovel heads are held by the Queensland Museum. Metal fishhooks rapidly replaced the shell ones, and wire (particularly fencing wire) quickly took the place of wooden points for spear ends. Eleven out of sixteen spears donated in 1903 by Roth to the Queensland Museum from Bloomfield had iron heads or barbs. Steel axes were valued items at Bloomfield and a number of observers note the willingness of Kuku-Yalanji men to undertake any amount of work for a European settler in return for these tools (see, for example Idrissi 1980 [1959]: 243). Roth (1898a) notes that blankets being given out by the police for Aborigines at Bloomfield were being used as sails for the canoes. Hershberger and Hershberger (1982 *pers. comm.*) saw a traditional canoe at Bloomfield in the early 1960s; generally though, wooden dinghies had replaced the outrigger canoe by the Second World War.

Kuku-Yalanji material culture in the late 1970s

A comprehensive description of Kuku-Yalanji material culture in the 1970s is not within the scope of this paper. Here I will merely give a few examples to demonstrate some of the continuities in knowledge and usage of items as well as some of the changes. The use of the bush by Kuku-Yalanji during the period 1977–1980 was an integral part of the mission economy (see Anderson 1982), and the following observations are restricted to material culture items relating to this 'bush component'.

Bush-food resources important during this time were fish, shellfish, pig, turtle and cassowary meat, wild fruits, hairy yam and the introduced 'New Guinea yam'. Spears were used for many species of fish, especially mullet. These spears were multi-pronged with fencing or other wire. Commercial string was used to bind the prongs, and this was covered with some combination of ironwood resin, car battery 'tar', 'Araldite' (store-bought glue), or asphalt tar. The handles were the same as in earlier days, as were the spear

throwers. Some substitutions in manufacturing technology for spears were apparent—for example, use of steel knives and use of margarine or butter instead of cassowary fat for greasing. Turtle hunting was done from boats with outboard motors, and while the harpoon handle was the same as in pre-contact times, European rope and steel harpoon points were used. Diving for freshwater eelfish and turtles in inland areas was done using diving goggles and a flexible steel rod. For land hunting .22 rifles were almost exclusively used.¹⁸ The stone ovens were often used for cooking meat in the bush camps I stayed in during my fieldwork. Traditional bark troughs and fire tongs of lawyer cane were also relied upon.

Fishing (without spears) was done with plastic hand reels and lines, metal fish hooks with no sinkers or floats. Bush vegetables were dug using mainly steel digging sticks, often a shortened and sharpened crowbar. Processing of *Dioscorea sativa* occurred on a number of occasions. Empty metal flour drums were used for boiling the yams; plastic buckets were used for separation of the yam mixture from the toxin; but the palm-fibre dilly bags were still used for the initial mashing. Only three or four women were able still to make the dilly bags in 1982 at Bloomfield. Metal billy cans made from old powdered milk tins were very common; machetes, metal files, shovels and steel axes were also in the bush camps. Plastic tarpaulins were normally laid on a bush frame, although knowledge of the old hut-type bush shelter was general amongst adults. Transport from the mission to bush camps was primarily by boat, but also by horse and truck.

Personal clothing styles for males at Bloomfield were heavily influenced by 'cowboy' or stockman style. Men wore riding boots for special occasions; western shirts and hats were common at all times. Elastic bandages were sometimes worn by young men on the arms and wrists in an exact parallel with the use of pandanus leaf bands. Both were thought to bring good luck and to demonstrate strength in fighting. Items used for sorcery purposes were mostly along traditional lines. New things which were used by men for 'love magic' included hair oil, scent and women's hankies. These were often mixed with traditional bush substances.

Older-style ceremonies were normally only held for fun or in association with funerals. At these, traditional south-eastern Cape York Peninsula dances and songs were performed with spear throwers used as clapping sticks. No body decoration was done for the dances but men

normally stripped to only shorts or trousers for dancing. Some 'Island style' (Melanesian) singing was occasionally done with empty flour tins used as drums with guitar accompaniment. In the mission generally, country and western music was the most popular form, with several people having guitars and an accordion for concerts of this music.

SOURCES

Sources of data for this paper have been both anthropological and historical. I conducted fieldwork of approximately fourteen months at Bloomfield River between 1977 and 1980, and a further month in 1982. Numerous other trips have occurred since then. Part of this work has involved reconstructing a picture of Kuku-Yalanji life prior to significant European activity in the Bloomfield region. Publications arising from this work with data relevant to the present paper include Anderson (1980; 1982; 1983; 1984). Very little earlier anthropological work exists. I have cited above the relevant works of W. E. Roth, Northern Protector of Aborigines in Cooktown from 1897 to 1905. McConnel (1931; 1939-1940) describes aspects of Kuku-Yalanji mythology and social organisation. Fortunately, several careful European observers lived in and visited the Bloomfield area in the late nineteenth century and early twentieth century. They accurately recorded a great deal of data on Kuku-Yalanji culture. D. Le Souef was a naturalist who visited Bloomfield several times in the 1890s and as I noted above,

the author Ion Idriess lived at Bloomfield for some time before the First World War. I have almost always been able to confirm the accuracy of their data from other sources. Roth and W.O. Hodgkinson, the Police Magistrate at Cooktown in 1886, both had access to European settlers at Bloomfield—Robert Hislop and Louis Bauer—both of whom were fluent in Kuku-Yalanji and had a deep understanding of Kuku-Yalanji culture.

Collections which contain Bloomfield River material culture items include the Roth Collections of the Queensland Museum in Brisbane and the Australian Museum in Sydney (see Kahn 1993). H. and R. Hershberger, linguists with the Summer Institute of Linguistics, lived and worked at Bloomfield from the early 1960s until the 1980s and have a good representative collection of Kuku-Yalanji items.

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ENDNOTES

- ¹ Because this paper is a reconstruction, I generally use the past tense. This is not to imply that some of the practices or material culture items are not still part of contemporary Kuku–Yalanji life. In general, I try to specify the date for a particular observation. As noted in the section, 'Sources', I have relied on a mixture of archival and oral sources for this paper. In addition, active learning and participation in bush activities has also been an important source of information. Although, some might think of such papers as old-fashioned, I am happy that this work can be a medium for transmission of knowledge from past generations to the young Kuku–Yalanji people of today.

- ² The earliest historical sources describe Kuku-Yalanji camps in just these locations (see King 1827; Le Souef 1896; Roth 1898a; Meek 1913, Rowan 1912).
- ³ Very few examples of these stone axes have been found in south-east Cape York Peninsula. Roth (1901a: 8) offered the explanation that in this area, 'the old discarded stone heads of the original axes have been utilised in large measure for lining the ground-ovens, a fact which will account in large measure for the paucity in this district of remains of these implements at the present day'.
- ⁴ King also commented on this. On both of his visits to Bloomfield, he and his men found what he termed 'huts' on the river bank and on the beaches. On his second trip in 1821 he noted that on the beach they 'found some natives' huts; some of which were of more substantial construction than usual' (King 1827, Vol.2: 14).
- ⁵ A set of these fire-sticks is in the Roth Collection at the Australian Museum (Kahn 1993: 118–119).
- ⁶ Roth was given this description by Mr. Robert Hislop, a European settler at Bloomfield whose property at Wyalla Plains contained one of the cycad-processing sites.
- ⁷ A Kuku-Nyungkul speaking man from the Annan River told me in 1977 that these dilly bags were also occasionally used as nets and were dragged through small lagoons, at least at Kings Plains just to the north of the Annan River area. Other than this, Bloomfield Kuku-Yalanji had no knowledge of nets being used (see Kahn 1993: 137–139).
- ⁸ This description was mostly obtained by watching Kuku-Yalanji women prepare this yam in 1978. I have also discussed with people the changes which have occurred in the process (e.g. the yams were boiled instead of roasted when I observed the process). Roth (1901a: 11–12) includes a description very similar to mine.
- ⁹ These stone ovens, termed *kurrma*, were still extensively used at Bloomfield in the 1980s, primarily for pig, eelfish and marine turtle. See Idriess (1980 [1959]: 255); and Roth (1901a: 8) for similar descriptions.
- ¹⁰ Roth (1902) includes a photograph of some young Aboriginal men at Cape Bedford Mission north of Cooktown playing this game.
- ¹¹ It is reported that one of the reasons for the relatively short lifespan of the *yiki-yiki* was that older men smashed them after growing weary of young men playing them for hours on end. Both Roth (1902: 24) and Idriess (1934: 67); 1980 [1959]: 199 mention this. An example of these 'trumpets' is in the Australian Museum collection (Kahn 1993: 127).
- ¹² Roth (1904: 12) states that at Bloomfield, before the underground piece was cut away, it would be tested by rubbing a firestick onto it, getting portions of the sticky covering to melt off, and trying them between the closed teeth—if sticky there, the gum would be suitable for use and further pieces removed.
- ¹³ Tindale (1974: 109) also reports that young cassowaries were tethered and reared by north Queensland rainforest Aborigines until fat enough to eat. For Bloomfield, though, the observers I have mentioned all noted that the pets were never fed enough to live for long in camp.
- ¹⁴ Roth (1910c: *passim*) notes that shell ornaments went through distinct fads and fashions in coastal Cape York Peninsula.
- ¹⁵ As a punishment for certain minor transgressions, people were also struck on the head with a spear thrower by an older man.
- ¹⁶ In the late 1970s this was the word used in Kuku-Yalanji for letters or for any written messages.
- ¹⁷ The ability to make strong barbed harpoons must have had a dramatic effect on the success of turtle expeditions. Roth (1909: 76) notes: '[t]he dependency of the turtle [hunting] upon iron (which is capable of piercing the carapace) was explained to me by the young men [of the Pennefather River] by reason of the fact that while wooden harpoons were in vogue these creatures could only be caught by striking them in the soft parts; i.e., the neck and posteriorly, and their capture was consequently no easy matter'.
- ¹⁸ Although the word *marrkin* was used in 1980 for 'rifle' (a word used throughout much of Cape York), the older word is *mirrba*. This is another name for the spear thrower used at Bloomfield during the formal 'trial by spear'.

A SPECIMEN OF GIANT SQUID, ARCHITEUTHIS SP., FROM SOUTH AUSTRALIAN WATERS

W. ZEIDLER & K. L. GOWLETT-HOLMES

Summary

This is the first record of Architeuthis from South Australian waters. The specimen was found floating off Cape Banks near Mount Gambier. The condition of the specimen indicated that it was only recently dead. Tissue samples were taken and are available for biochemical analysis. Illustrations of the specimen are provided together with details of meristic characters. The specimen, a female, had a dorsal mantle the length of 1.53 m, a head length of 0.32 m; the tentacle which had become detached, measured 7.39 m, and altogether it weighed 86 kg.

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ZEIDLER, W. & GOWLETT-HOLMES, K. L. 1996. A specimen of giant squid, *Architeuthis* sp., from South Australian waters. *Records of the South Australian Museum* 29(1): 85–91.

This is the first record of *Architeuthis* from South Australian waters. The specimen was found floating off Cape Banks near Mount Gambier. The condition of the specimen indicated that it was only recently dead. Tissue samples were taken and are available for biochemical analysis. Illustrations of the specimen are provided together with details of meristic characters. The specimen, a female, had a dorsal mantle the length of 1.53 m, a head length of 0.32 m; the tentacle which had become detached, measured 7.39 m, and altogether it weighed 86 kg.

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Specimens of *Architeuthis* have been recorded from most of the world's oceans, most frequently from Newfoundland, Northern Europe, Japan, South Africa and New Zealand (Aldrich 1991; Clarke 1966, 1980; Clarke & MacLeod 1982; Roper & Boss 1982). Most of these recent records are those of strandings or from the stomachs of sperm whales. More recently, specimens have been caught by deep-sea trawls (e.g. Jackson *et al.* 1991) and only in January this year a specimen slightly larger than the South Australian one was caught off King Island, Bass Strait and an even larger one was caught 500 km off the South Island of New Zealand.

In Australia there have been occasional, but usually unconfirmed, reports of large squid floating off the southern Australian coast. Some of these are probably of *Taningia danae* (Zeidler 1981) while others most likely represent *Architeuthis*, as confirmed by this report.

The first record of *Architeuthis* from Australian waters is by Allan (1948) who recorded a specimen which was washed ashore at Wingan Inlet, Victoria in mid-September, 1948. It had a mantle length of 2.3 m. The specimen was considerably mutilated with the tentacles missing and the internal organs and gladius had been removed. Only 'the head with arms, and tail with fins, were preserved for future reference'.

Another two specimens were obtained from the stomachs of sperm whales caught by the Cheynes Beach Whaling Company, Albany, Western Australia, in late 1978 (Anon. 1980). The largest specimen weighed 280 kg and was used in promotional displays; its current whereabouts is

unknown. The second, much smaller, specimen is preserved at the Wallaroo Heritage and Nautical Museum, South Australia. Clarke (1980) also recorded the beaks and flesh of *Architeuthis* from the stomachs of sperm whales caught near Albany.

The only other, previous, records of *Architeuthis* from Australian waters (apart from the one caught in January this year) are that of a larval specimen (mantle length 10.3 mm) caught in the Tasman Sea, 33°19.4'S 155°00.3'E, at a depth of 20 m (Lu 1986) and a female (mantle length 42.2 cm) from the same area, 33°44'S, 153°00'E, taken in a oblique trawl from the surface to a depth of 600 m (Jackson *et al.* 1991).

The specimen which is the subject of this report (Fig. 1) was found floating on the surface, recently dead, about 3.2 nautical miles SSE of Cape Banks (37°56.32'S 140°20.79'E) over a bottom depth of about 25 m. It was found by Mr. M. Von Stanke on FV 'Ocean Lady' on 9 March, 1995 and is now preserved in the South Australian Museum (SAM D18936).

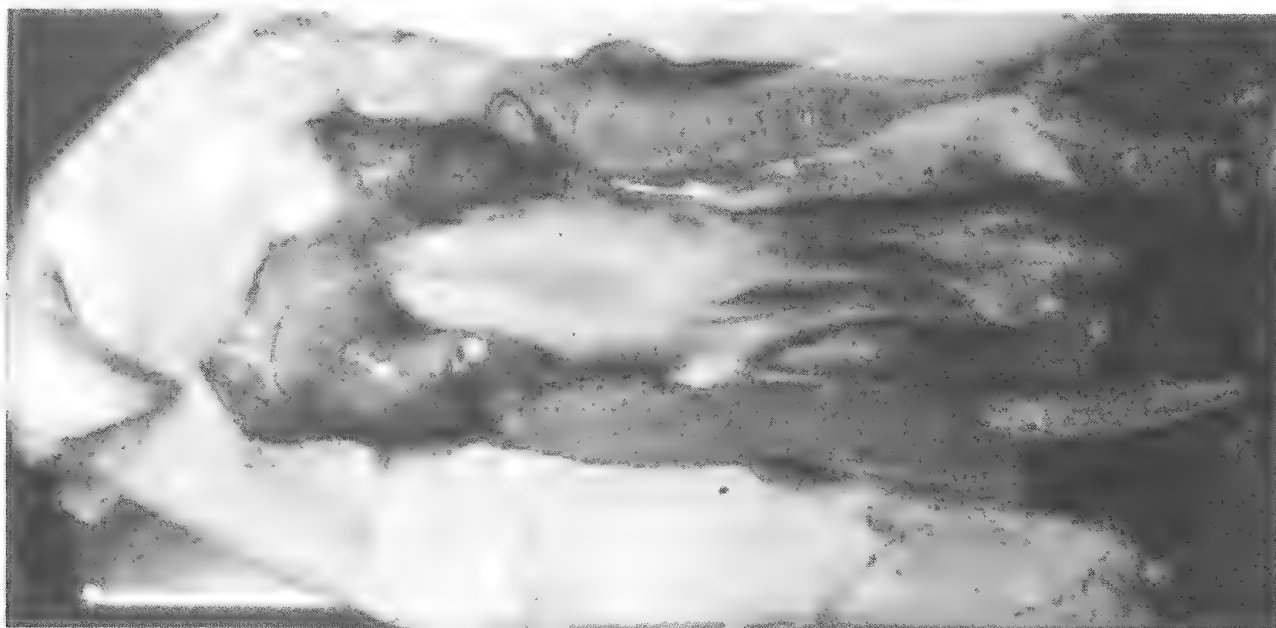
The relatively good condition of the present specimen is significant because live specimens are rarely captured and most stranded specimens are partly decomposed and incomplete as are specimens from whale stomachs. It was immediately stored on ice and transported to the Museum the next day without being frozen.

Tissue samples were taken from the digestive gland and from one of the arms and frozen in liquid nitrogen before being stored in a deep freeze at -80° C. Samples of muscle were also

1



2



FIGURES 1,2. *Architeuthis* sp. 1, whole female, dorsal mantle length 1.53 m; 2, internal organs – note white bilobed midamental glands between gills.

TABLE 1. *Architeuthis* sp. (SAM D18936) meristic characters

Character	Measurement (mm)
Body	
Mantle length (dorsal)	1 530
Mantle length (ventral)	1 400
Mantle width (flattened)	440
Mantle thickness (max.)	40
Fin length including 'tail' (damaged)	430
Fin width (right) to edge of mantle (ventral view)	175
Funnel length	250
Funnel width across opening	110
Locking cartilage, length	190
Locking cartilage, width (max.)	50
Gladius length	1 440
Gladius width (max.)	190
Rachis length	340
Rachis width (max.)	130
Head (detached)	
Length	320
Width	270
Eye orbit diameter (eyes missing)	170
Distance between eye orbits (dorsally)	90
Radula length (curled)	70
Radula width (between teeth, max.)	10
Arms (all damaged with most tips missing)	
Left I	810
Left II	1 450
Left III	1 330
Left IV	1 140
Right I	610
Right II	1 120
Right III	1 290
Right IV	1 750
Sucker diam., largest from left I	14
Sucker diam., smallest from left I	7
Tentacles	
Left (club etc. missing)	4 260
Right (club detached)	2 970
Right total	7 390
Club and part of tentacle	4 420
Dactylus	195
Manus	410
Carpus	130
Width of club (max.)	50
Club sucker – largest diameter	25

taken from the mantle and tentacle and preserved in 100% alcohol. Both the frozen (SAM B80) and alcohol-fixed (SAM XD0040) samples are available for biochemical analysis.

We have not provided details of the internal anatomy (Fig. 2) as this is beyond our expertise but in Table 1 we provide details of meristic characters following Roper and Voss (1983). All measurements were made prior to preservation. The body weighed 48 kg and the head with arms and tentacles weighed 38 kg.

The tips of all the arms were missing, or severely damaged, so it was not possible to determine the sex externally. On dissection the specimen proved to be a female with the gonad full of small white eggs.

The gladius was removed and preserved separately. It was relatively fragmented and the illustration (Fig. 3) was produced by tracing the outline of pieces as they were removed. Dimensions are given in Table 1.

The beaks (Fig. 4) and radula (Fig. 5) were also removed and preserved separately. The dimensions of the beaks (Table 2) are according to Wolff (1984). The radula is like that illustrated by Roper and Boss (1982), each row consists of 7 teeth with marginal plates, central tooth tricuspid, central cusp twice as long as outer cusp; first lateral teeth bicuspid, inner cusp twice as long as outer cusp; second and third lateral teeth with large, single cusps, horn-like; marginal plate reduced to small knob. The first 17 rows show little wear and breakage, but the next 26 rows show moderate to severe wear, with the cusps on the central teeth, and to a lesser extent on the first

TABLE 2. *Architeuthis* sp. (SAM D18936) beak dimensions

Character	Measurement (mm)
Upper beak	
Hood length	75
Rostral length	18
Wing width	22
Rostral tip to inner margin of wing	37
Wing to crest length	94
Crest length	107
Crest depth (central)	45
Jaw angle width	15
Lower beak	
Rostral tip to inner posterior corner of lateral wall	74
Rostral length	18
Rostral tip to inner margin of wing	63
Wing length	52
Jaw angle width	15
Crest depth (central)	32



FIGURE 3. *Architeuthis* sp. Illustration of the gladius, 1.44 m length. Scale = 50cm.

lateral teeth, being completely worn away in many rows. The remaining rows are teeth still forming or not yet in use.

Only one of the tentacles with the club end (Figs 6 & 7) was present when the specimen was collected and that became detached when the specimen was retrieved from the ocean. It is the right tentacle which combined with the remnant section on the head measured 7.39 m.

The stomach contained nine squid suckers and the remains of others, but was otherwise empty. The suckers are without the sucker rings so it is impossible to determine the taxon from which they came with certainty other than that they came from a relatively large species; the suckers ranging in size from 13 mm to 16 mm in diameter. According to Roper and Boss (1982) most specimens collected have empty stomachs as active, well-fed, animals are unlikely to become stranded and even if something was to be found in the stomach it would be difficult to identify because the radula and beak shred prey into small pieces and the digestive enzymes work rapidly. Nevertheless *Architeuthis* seems to feed on small fish and large invertebrates such as other cephalopods which is supported, in part, by the present findings.

Virtually nothing is known about *Architeuthis* in Australian waters. The present specimen had two large gashes (approx. 20 cm) through the left side of the mantle, suggesting that it may have been attacked by a predator such as a sperm whale although no whales were reported in the region at the time. The specimen was in extremely good condition indicating that it was only recently dead and although it was found floating relatively close to the shore in water of only 25 m depth the Continental Shelf drops off rapidly along that part of the coast to a depth of 1100 m within 20 nautical miles. More information on the biology of these animals is given by Clarke (1966, 1980) and Aldrich (1991) and information on juvenile stages is provided by Roper and Young (1972), Roper and Boss (1992) and Roper (1992).

ACKNOWLEDGMENTS

We are most grateful to Mr Martin Von Stanke, Carpenter Rocks, South Australia for collecting the specimen of *Architeuthis* and for donating it to the South Australian Museum. Mr Thierry Laperousaz, South Australian Museum, is thanked for helping to transport the specimen to the Museum. Ms Jan Forrest, South

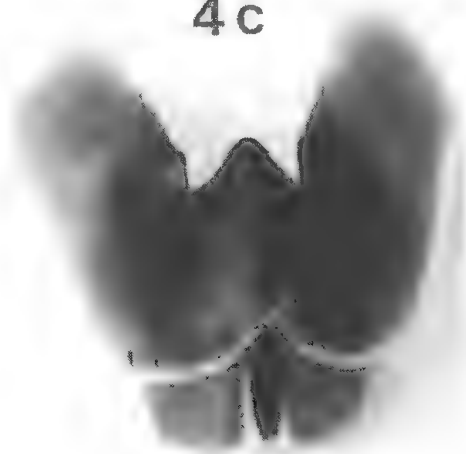
4a



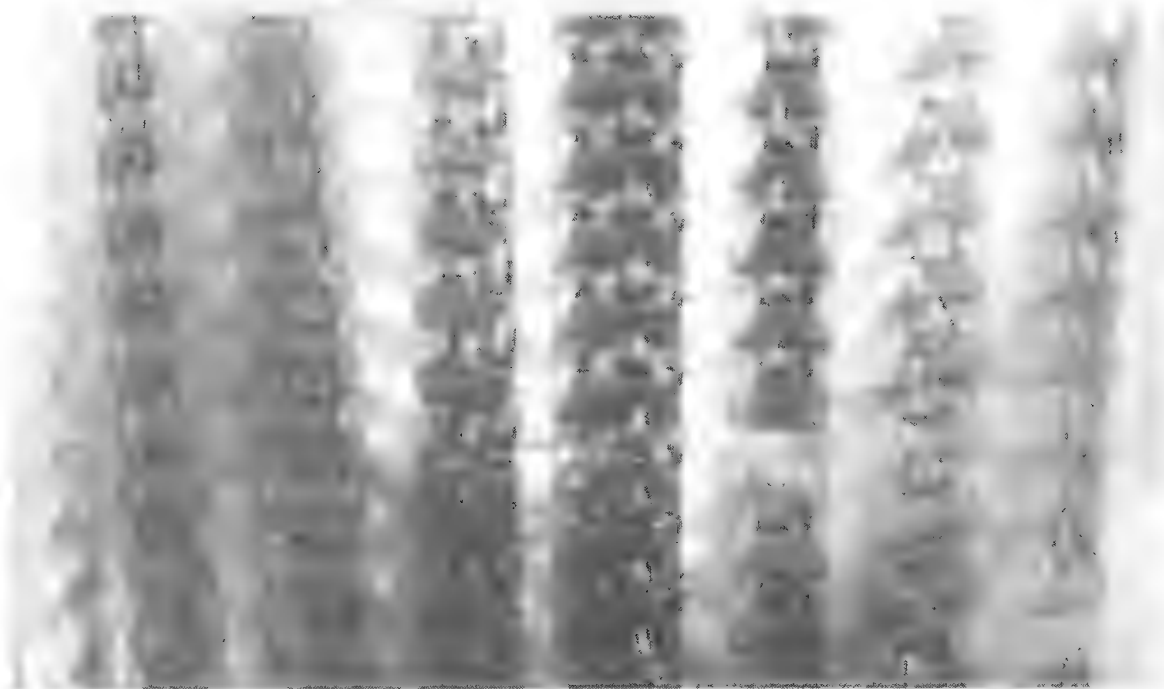
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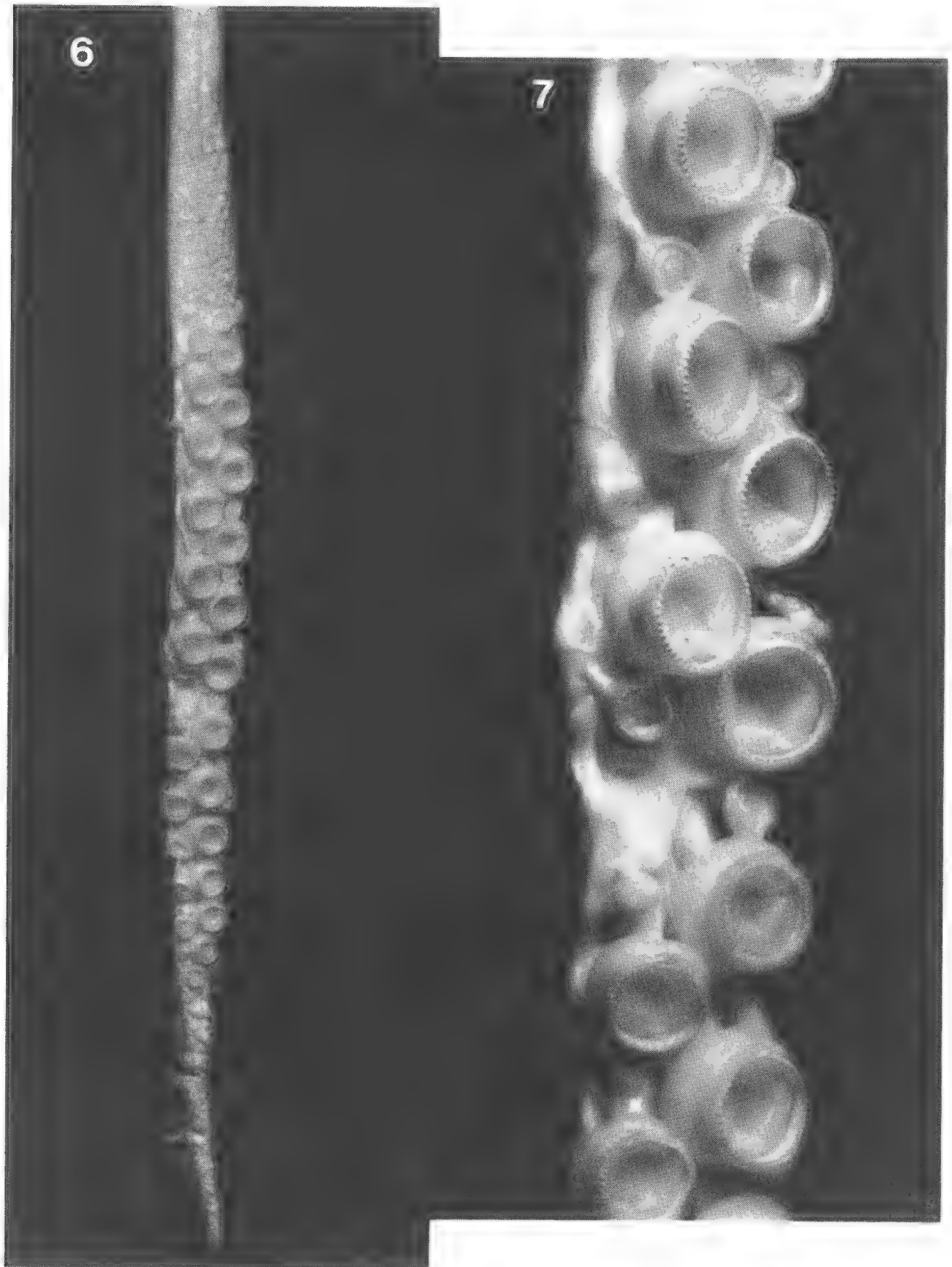
4c



5



FIGURES 4,5. *Architeuthis* sp. 4a, upper beak; 4b,c, lower beak; 5, part of radula from sac, not worn.



FIGURES 6,7. *Architeuthis* sp. Right tentacular club and enlargement of manus illustrating suckers.

Australian Museum, is gratefully acknowledged for all of the photographs (except Fig. 1). An anonymous referee and Dr C. F. E. Roper, Smithsonian Institution,

Washington D.C., provided many useful comments which much improved the manuscript. Mrs Vicki Wade and Robyn Cherrington typed the manuscript.

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A NOTE ON TWO SIPUNCULANS (SIPUNCULA) AND AN ECHIURAN (ECHIURA) FROM PRYDZ BAY, ANTARCTICA

STANLEY J. EDMONDS & WOLFGANG ZEIDLER

Summary

Several sipunculans and an echiuran were collected in the region of Prydz Bay (between the Australian bases of Davis and Mawson) during the summer of 1991 by one of us (WZ) and K. Gowlett-Holmes of the South Australian Museum while on board Australia's ice breaker 'Aurora Australis' during a Marine Science voyage organised by ANARE (Australian National Antarctic Research Expeditions). Although the species have been previously reported from the Falkland Islands, Graham Land, Ross Sea and Commonwealth Bay the present findings on the opposite side of the continent confirm that their distribution is circum-polar.

A NOTE ON TWO SIPUNCULANS (SIPUNCULA) AND AN ECHIURAN (ECHIURA) FROM PRYDZ BAY, ANTARCTICA

Several sipunculans and an echiuran were collected in the region of Prydz Bay (between the Australian bases of Davis and Mawson) during the summer of 1991 by one of us (WZ) and K. Gowlett-Holmes of the South Australian Museum while on board Australia's ice breaker 'Aurora Australis' during a Marine Science voyage organised by ANARE (Australian National Antarctic Research Expeditions). Although the species have been reported previously from the Falkland Islands, Graham Land, Ross Sea and Commonwealth Bay the present findings on the opposite side of the continent confirm that their distribution is circum-polar.

Specimens were obtained from the by-catch of exploratory fishing trawls using an International Young Gadoid Pelagic Trawl (IYGPT) net and preserved in 2% formaldehyde/propylene glycol solution; later transferred to 75% alcohol. The specimens are deposited in the South Australian Museum (SAM).

Material was collected from the following stations as designated by ANARE:

Stn. 24B; 67°30.87'S, 73°33.68'E to 67°29.20'S, 73°31.04'E; 576–581 m; 25 Jan. 1991.

Stn. 77; 67°57.95'S, 76°20.58'E to 67°56.36'S, 76°23.51'E; 441–436 m; 19 Feb. 1991.

Stn. 78; 68°27.91'S, 75°26.60'E to 68°26.11'S, 75°24.33'E; 622–616 m; 19 Feb. 1991.

Stn. 79; 68°58.33'S, 74°23.84'E to 68°56.48'S, 74°24.33'E; 787 m; 19 Feb. 1991.

Stn. 84; 68°03.77'S, 73°09.33'E to 68°02.66'S, 73°12.60'E; 683–680 m; 21 Feb. 1991.

Stn. 90; 67°00.25'S, 72°40.21'E to 66°58.53'S, 72°36.91'E; 536–532 m; 24 Feb. 1991.

SIPUNCULA

Golfingia margaritacea margaritacea (Sars, 1851)

Sipunculus margaritaceus Sars, 1851: 196–197

Synonymy – see Cutler (1994: 71–72)

Material examined (no. of specimens in brackets)

Stn. 77, SAM E1164 (2); Stn. 78, SAM E1174 (1); Stn. 84, SAM E1173 (10); Stn. 90, SAM E1175 (1).

Description

Specimens large, stout, cylindrical or sausage-shaped. Trunk of two largest 95–105 mm, maximum width 25–30 mm. Posterior extremity rounded. Body wall thick, covered with very small white papillae. Longitudinal musculature continuous. Introvert much more slender than trunk, not fully everted in any specimen, estimated length in largest specimen 40 mm; no spines or hooks. Two pairs of retractor muscles arising at different levels from anterior half of trunk. Two fastening muscles; spindle muscle not fixed posteriorly. Numerous (up to 22) tightly wound, double, intestinal coils. Wing muscle present. Caecum in one dissected specimen but not in a second. Contractile vessel simple. Two free nephridia.

Remarks

On comparing specimens there is no doubt that those from Prydz Bay are conspecific with those from the Ross Sea, described by Edmonds (1965) as *G. margaritacea capsiformis*. The synonymies given by Stephen and Edmonds (1972: 94) and Cutler and Cutler (1987: 743), however, show that *G. margaritacea* and its subspecies are amongst the most commonly reported sipunculans and that the differences between the subspecies are often of doubtful significance and taxonomic importance. On morphological grounds Cutler and Cutler (1987) consider that the best name for most of the reported subspecies to be *G. margaritacea margaritacea*. Their conclusions have been accepted in the present paper.

Distribution

Golfingia margaritacea margaritacea is circum-polar at the Antarctic. A number of previous workers (listed in Edmonds 1965) consider it to be bi-polar also. Cutler & Cutler (1987) state that '*G. margaritacea margaritacea* is a widely distributed taxon, living in all sections of the Atlantic, Arctic and Antarctic Oceans, the North-, South-east and South-west Pacific...'

Golfingia anderssoni (Théel, 1911)

Phascolosoma anderssoni Théel, 1911: 28–29

Golfingia anderssoni – Edmonds 1965: 30–31

Material Examined

Stn. 24B, SAM E1629 (1); Stn. 84, SAM E1628 (6)

Description

Specimens long, cylindrical but most twisted and damaged. Best specimen possesses a thin, tapering caudal appendage 12 mm long covered with small papillae but posterior 20 mm of trunk bears prominent, swollen, bladder-like papillae. Maximum length of trunk from tip of caudal appendage to base of introvert 175 mm, maximum width (posteriorly) 9 mm. Introvert slender, about 140 mm long, anterior tip missing. Longitudinal musculature continuous. Four retractor muscles, a stout ventral pair and a more slender dorsal pair, the latter arising more anteriorly than former. No introvert hooks or spines. Contractile vessel simple. Two tubular, free nephridia.

Remarks

Although the specimens were damaged, the presence of four retractor muscles, a caudal appendage and prominent, swollen papillae on the posterior region of the trunk enables them to be identified as *G. anderssoni*.

Distribution

Most common in Antarctic and sub-Antarctic waters, including Graham Land, South Georgia, Ross Sea and now Prydz Bay. Circum-polar.

ECHIURA

Echiurus sp.*Material examined* (no. of specimens in brackets)

Stn. 79, SAM E1630 (2); Stn. 84, SAM E1631 (2).

Description

Specimens badly damaged, lacking a proboscis and internal organs. The identification as *Echiurus* is based on the presence of two ventral setae anteriorly, two imperfect circles of large setae surrounding the posteriorly placed anus and some circles of large papillae ringing the anterior of the trunk. No other details can be given with certainty.

Remarks

Echiurus antarcticus Spengel, 1912 has been reported from Chile (Wesenberg-Lund 1955) and South Georgia (Spengel 1912; Stephen 1941).

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We are indebted to the captain Roger Russling, and the crew of the RSV 'Aurora Australis' for making the collection of material possible. Dick Williams, the voyage leader, is thanked for providing ready access to the bycatch and for his leadership. All costs while on board ship and in Antarctica were met by ANARE, other funds for this work were provided by the South Australian Museum.

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MARCH 1997

REVISION OF THE LARVAE OF PARATROMBIUM (ACARINA : TROMBIDIIDAE) OF AUSTRALIA AND PAPUA NEW GUINEA, WITH NOTES ON LIFE HISTORIES

R. V. SOUTHCOTT

Summary

The larvae of *Paratrombium* Bruyant, 1910 (Acarina: Trombidiidae) of Australia and Papua New Guinea are described, from four new species: *P. australe*, sp. nov. and *P. lindsayi*, sp. nov. from southern Australia, *P. curculionis* sp. nov. from northern Queensland, and *P. anemone*, sp. nov. from Papua New Guinea. The larvae of *P. australe* and *P. lindsayi* are correlated with adults by experimental rearing, with description of the ovum and prelarva, and attempts to find suitable larval hosts; these larvae experimentally parasitized small Diptera and Hymenoptera, and a species of Mantisipidae (Neuroptera). The adults of *P. australe* and *P. lindsayi* are compared with previously described Australian adults of *Paratrombium*. Nomenclatural changes for previously described Australian adults of *Paratrombium* are proposed.

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R. V. SOUTHCOTT

SOUTHCOTT, R. V. 1997. Revision of the larvae of *Paratrombium* of Australia and Papua New Guinea, with notes on life histories. *Records of the South Australian Museum* 29(2): 95–120.

The larvae of *Paratrombium* Bruyant, 1910 (Acarina: Trombidiidae) of Australia and Papua New Guinea are described, from four new species: *P. australe*, sp. nov. and *P. lindsayi*, sp. nov. from southern Australia, *P. curculionis*, sp. nov. from northern Queensland, and *P. anemone*, sp. nov. from Papua New Guinea. The larvae of *P. australe* and *P. lindsayi* are correlated with adults by experimental rearing, with description of the ovum and prelarva, and attempts to find suitable larval hosts; these larvae experimentally parasitized small Diptera and Hymenoptera, and a species of Mantispidae (Neuroptera). The adults of *P. australe* and *P. lindsayi* are compared with previously described Australian adults of *Paratrombium*. Nomenclatural changes for previously described Australian adults of *Paratrombium* are proposed.

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Paratrombium Bruyant, 1910 was founded for a larval European mite, *P. egregium* Bruyant, 1910. Although its original author recognized its trombidioid affinities, and (1912) recorded it as a parasite of *Pompilus pectinipes* Lind. (Hymenoptera), the genus was not correlated with its post-larval instar until Feider (1952), in Europe, reared larvae from ova laid by the adult *P. divisipili* (Feider, 1950). Newell (1958) described as new two North American species, *P. bidactylus* Newell, 1958 and *P. quadriseta* Newell, 1958, which he had successfully reared from adults. Robaux (1969), in Europe, successfully reared and described larvae from an adult he identified as *P. megalochirum* (Berlese, 1910). Earlier, an uncorrelated species, *P. meruense* (Trägårdh, 1908), had been described from eastern Africa; it was redescribed by Oudemans (1912).

While the larval *Paratrombium* is well characterized and easily recognized (e. g. by being the only known trombidioid larva with a pectinate medial coxala I), the same does not apply with the adults. Hirst (1928a,b 1929) placed some Australian adults of *Paratrombium* in *Microtrombidium* Haller, 1882 and *Dinothrombium* Oudemans, 1910, and Womersley (1934) also placed some adults in *Caenothrombium* Oudemans, 1927. Among adult forms was *Caenothrombium miniatum* Womersley, 1934, for which Southcott (1986) erected *Pollicotrombium* Southcott, 1986.

In this paper four new species of *Paratrombium* are described from larvae, three from Australia and one from Papua New Guinea. The two southern Australian species, *P. australe* sp. nov. and *P. lindsayi* sp. nov., have been successfully reared from adults, and their adult and other instars are also described.

MATERIALS AND METHODS

Adults and larvae of trombidioid mites have been collected by the author over many years, either free-living, or by extraction of samples of soil and litter with the Berlese funnel. Initial Berlese funnel extractions were into 70% ethanol; later ones were extracted free-living, for biological observation. Most collecting was done in eucalypt forests in the Mt Lofty Ranges, South Australia. A few specimens were forwarded from other collectors.

Adults used in possible rearing experiments were placed in small glass tubes, with a small amount of damp soil or bark from the collection locality; tubes were closed with well-fitting corks, with a face free from cracks, after being trimmed with a razor.

Some batches of eggs collected in the field were confined similarly, and some of these hatched into larvae. Adults died soon after oviposition and decomposed, with some mould development and

some degree of limb disarticulation; they were mounted through standard water-soluble media (initially Berlese's gum chloral medium, then polyvinyl alcohol media, and finally Hoyer's gum chloral medium). Most disarticulation of adults was mild; where severe, leg segments were recognized by shape and measurements.

Larvae swarming in the tubes were found to be positively phototropic, allowing small numbers to transfer into other tubes for experiments to find possible insect hosts for them to parasitize.

Microscopy was by Leitz Ortholux/Laborlux microscope with phase-contrast and polarizing facilities. All drawings were made with the aid of a drawing apparatus.

Seta and other anatomical terminology follows Southcott (1992, 1993, 1994).

All measurements are in micrometres (μm) unless otherwise specified.

Abbreviations are as follows: SAM = South Australian Museum, Adelaide; RVS = R. V. Southcott

SYSTEMATICS

Family TROMBIDIIDAE Leach

Subfamily TROMBIDIINAE Leach

Trombidiidae Leach, 1815: 395 (as Trombidides)

Trombidiinae Southcott, 1986: 8

For additional synonymy see Southcott 1986: 8

Type genus *Trombidium* Fabricius, 1775.

Genus *Paratrombium* Bruyant

Paratrombium Bruyant, 1910: 347; Southcott 1986: 43.

For additional synonymy see Southcott 1986: 43.

Type species: *Paratrombium egregium* Bruyant, 1910.

Definition of larva: as in Southcott 1986: 43, and additionally: supracoxala present on gnathosoma and on leg I.

Definition of adult: as in Southcott 1986: 43.

KEY TO THE LARVAE OF *PARATROMBIUM* OF THE WORLD

1. Posterior dorsal scutum with four setae
..... *P. quadriseta* Newell, 1958
- Posterior dorsal scutum with two setae 2

- 2 (1). Posterior claw of tarsus III not reduced ... 3
- Posterior claw of tarsus III reduced 7
- 3 (2). AM setae stout, tusk-like 4
- AM setae not stout, tusk-like 5
- 4 (3). MA/AP 1.43–1.82. Medial coxala I with 15–20 digitations *P. australe* sp. nov.
- MA/AP 1.84–2.29. Medial coxala I with c. 27 digitations *P. lindsayi* sp. nov.
- 5 (3). Medial coxala I with about 17 digitations. Tritorostral setae expanded, with several blunted digitations *P. anemone* sp. nov.
- Medial coxala I with less than 17 digitations. Tritorostral setae not or little expanded, with numerous fine, pointed setules 6
- 6 (5). L > 200 μm . SB > 150 μm . Medial coxala I with 9 digitations
..... *P. meruense* (Trägårdh, 1908)
- L < 200 μm . SB < 150 μm . Medial coxala I with 12–13 digitations
..... *P. curculionis* sp. nov.
- 7 (2). Tritorostral setae of gnathosoma slender, tapering throughout
..... *P. bidactylus* Newell, 1958
- Tritorostral setae of gnathosoma not slender and tapering 8
- 8 (7). Medial coxala I with 14–16 digitations
..... *P. megalochirus* (Berlese, 1910)
- Medial coxala I with less than 13 digitations 9
- 9 (5). Tritorostral setae moderately thickened in their central part, with a heavy coating of short setules; setae of posterior dorsal scutum placed before middle of scutum; SB < PW *P. egregium* Bruyant, 1910
- Tritorostral setae apparently considerably thickened with long setules, so that they appear markedly enlarged in their distal half; setae of posterior dorsal scutum placed behind middle of scutum. SB not < PW *P. divisipili* (Feider, 1950)

* This criterion is assumed to be the case with *P. meruense*; according to Oudemans (1912: 97) the holotype larva (the sole specimen) lacked the gnathosoma.

Paratrombium australe sp. nov.

(Figs 1A, B, 2A–D, 3, 4A–G)

Material examined

Holotype. South Australia. Myponga, reared larva ACB294L3, reared 29.xi.1947, from ova laid by adult ACB294A, R.V. Southcott. SAM.

Paratypes. South Australia. Myponga, 12.x.1947, adult female ACB294A, also reared larvae ACB294L1–2, 5–8 (see details under Biology). Workanda Creek, National Park, Belair, 27.x.1951, many ova, from which larvae emerged, R.V.S., ACB546 (see under Biology). Adult ACB585A, with idiosoma length 2130, width 1260, 30.viii.1953, RVS, which laid ova which produced many larvae, including ACB585L1–12 (see Biology). SAM.

Diagnosis of larva

Posterior dorsal scutum with two setae. Posterior claw of tarsus III not reduced. AM setae thickened, pointed, tusk-like. Medial coxala I with 15–20 digitations. Odontus strongly curved, diverging into two well-separated tines. Tritorostral setae curved, pointed, with a brush of fine setules in distal 2/3. MA/AP 1.43–1.82.

Diagnosis of adult

PDS to c. 100µm long.

Description of holotype larva (Figs 1A, B, 2A–D), supplemented by paratypes

Colour in life red. Idiosoma 420 long by 215 wide; total length to tip of cheliceral blades 450.

Anterior dorsal scutum porose, smooth; anterior border rounded (a slight anterior central depression appears to be an artefact of mounting), lateral and posterior borders almost straight, smooth; posterolateral angles rounded. AM scutalae stout, smooth, pointed, tusk-like; other scutalae of anterior scutum tapering, pointed, thinner, AL setae smooth, PL setae with a few fine setules. Sensillary setae filamentous.

Posterior dorsal scutum (scutellum) porose, semicircular, with smooth borders; anterior border straight, anterolateral angles rounded, posterior border convex; with two scutalae similar to PLs of anterior dorsal scutum.

Metric data as in Table 1.

Each eye pair posterolateral to anterior dorsal scutum; eyes rounded, anterior 11 across, posterior 7.

Dorsum of idiosoma behind scutellum with c. 20 setae, strong, tapering, pointed, with slender, outstanding setules; each seta arising from a

conical papule; setae arranged 2, 2, 6, 2, 4, 2, 2 (pygosomals).

Ventral surface of idiosoma (Fig. 2A): between coxae III two slender, pointed setae, 70 long, with slender setules. Behind coxae III are eight setae, similar to dorsals, arising from papillae, 70–75 long, arranged 2, 4, 2 (pygosomals).

Legs of usual trombidoid stature. Leg lengths (including coxae and claws): I 475, II 450, III 490. Medial coxala I 65 long, bearing 15–16 long, thin, pointed digitations, arising somewhat obliquely to main axis (Fig. 2C). Lateral coxala I arises at anterolateral angle of coxa, slender, pointed, c. 90 long, with a few long, slender setules; above posterior cornu of coxal joint a thin, pointed supracoxala, 13 long. Urstigma at posterolateral angle of coxa I, narrow, curved, 36 long by c. 15 wide. Coxa II with two slender, pointed setae with a few slender setules; anterior seta 73 long, posterior seta 75 long. Coxala III similar, 80 long. Leg scobalae curved, tapering, pointed, with slender setules. Scobalar formula (legs I, II, III): Fe 5, 4, 4, Ge 4, 3, 3, Ti 5, 5, 5.

Leg specialized setae: SoGeI.26d(40), SoGeI.57ad(33), VsGeI.73d(9), SoTiI.49d(33), SoTiI.79d(27), VsTiI.88pd(c.5), SoGeII.45d(36), VsGeII.83d(10), SoTiII.33d(c.33), SoTiII.63d(c.23); Vs absent. SoGeIII.44d(27).

Tarsus I with SoTaI.56d(34), FaTaI.59ad(c.2), SeTaI.74d(43) ('tectal eupathidala'), Pt 20 long. Tarsus II with SoTaII.46d(c.27), FaTaII.46pd(2). Tarsal claws smooth, falciform, equal; empodium of each tarsus over-reaching claws.

Gnathosoma: combined cheliceral bases spindle-shaped, 78 long by 58 across. Cheliceral digits curved, 46 long, with apical 'chisel end'. Tritorostral setae simple, curved, pointed, c. 13 long. Deutorostral setae absent. Tritorostral setae (Fig. 2B) curved, 25 long, with a brush of setules in distal 2/3. Behind posterior margin of palpal trochanter a simple, pointed seta (blunted in holotype) (palpal supracoxala) 4–5 long.

Palpi compact; femur with dorsal, simple, pointed seta 13 long. No genual setae. Tibia with three simple setae. Odontus strongly curved, with two divergent tines (Fig. 2D). Palpal tarsus with six pointed setae, three with a scythe-like appearance, also one or two minute blunted projections (?solenoidae).

Description of adult female ACB294A, slide-mounted, supplemented by ACB585A (Figs 3, 4A–F)

Colour in life red. Idiosoma 3400 long by 2000 wide; total length to tip of cheliceral blades 3750.

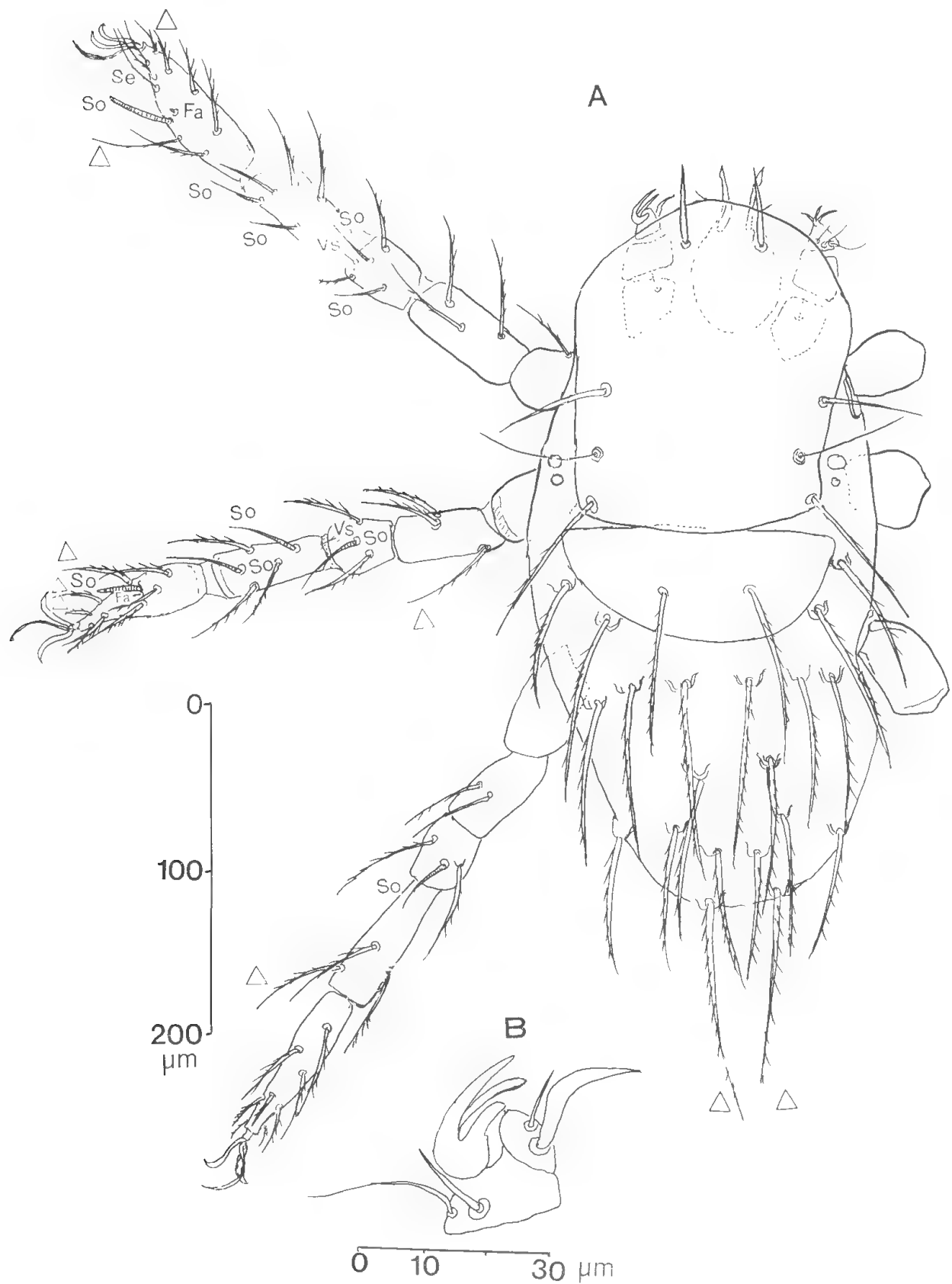


FIGURE 1. *Paratrombium australe* sp. nov., larva, holotype. A, Dorsal view, to standard symbols; on right, legs omitted beyond trochanters. B, Palpal tibia and tarsus, dorsomedial aspect, further enlarged.

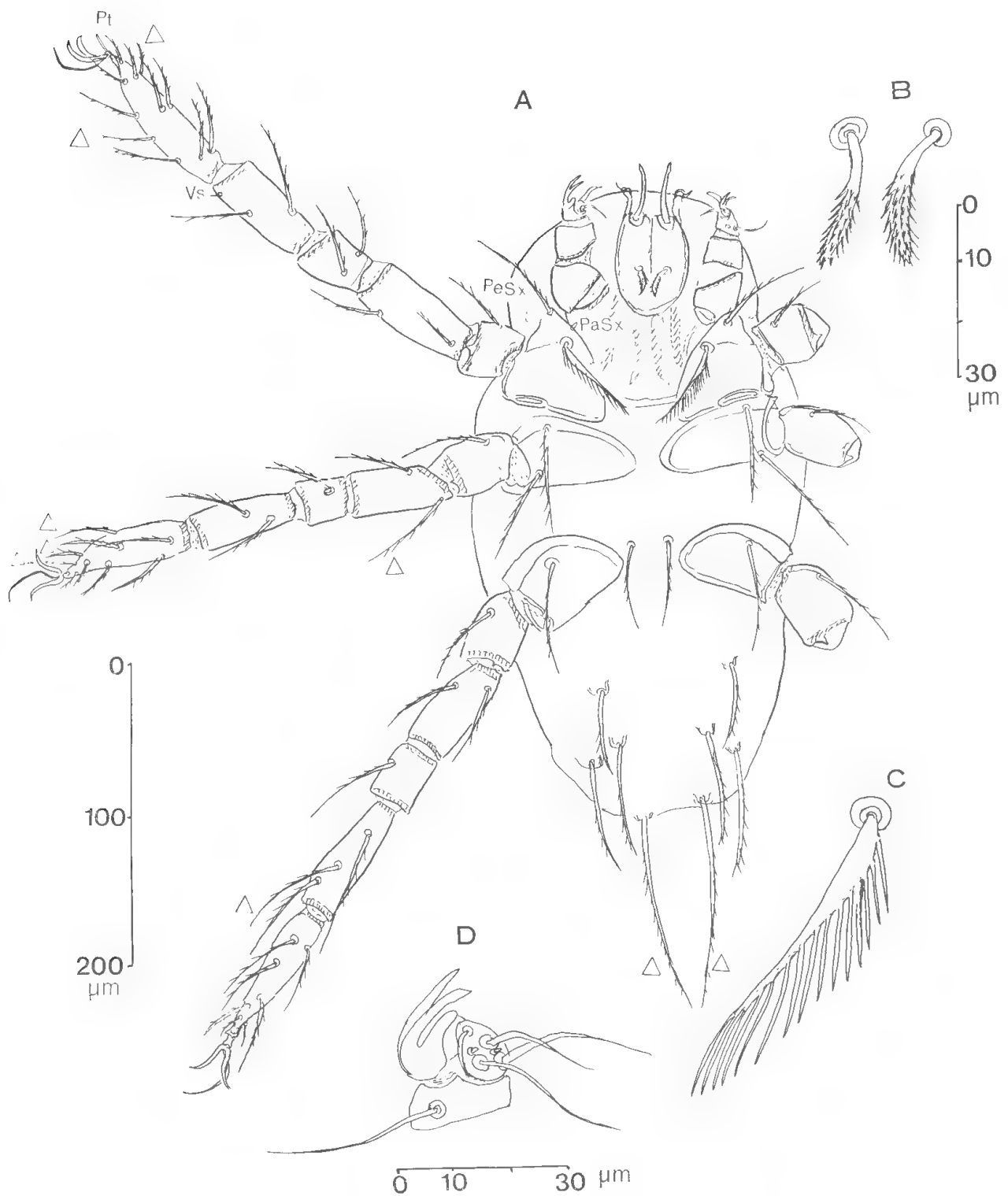


FIGURE 2. *Paratrombium australe* sp. nov., larva, holotype. A, Ventral view, to standard symbols; on right, legs omitted beyond trochanters. B, Tritorostral setae. C, Medial coxala I. D, Palpal tibia and tarsus, ventrolateral aspect. (PaSx palpal supracoxala; PeSx pedal supracoxala). (Each to nearest scale.)

Crista well developed, with strong, broad, crescentic, transverse anterior extension ('vomer') carrying pointed setulose setae 28–42 long in its anterolateral parts; more posteriorly the vomer is poorly defined, and carries similar setae to 150

long (Fig. 4A). Sensillary setae filiform, arising from a well-defined expansion of the crista; posterior end of crista well-defined, blunt-ended. Each eye pair on a large peduncle, with a lens, at about the middle, 64 across and a distal eye 60

TABLE 1. Metric data of *Paratrombium australe* sp. nov., larvae (* for maximum values).

Character	Population from toptype area, Myponga, S.A.						Population from Workanda Creek, S.A.				
	Holotype	n	range	mean	s.d.	c.v.	n	range	mean	s.d.	c.v.
LN	27	7	22-27	24.4	2.15	8.5	12	19-24	22.0	1.13	5.1
MA	98	7	97-104	100.6	2.94	2.9	12	93-105	99.8	3.47	3.5
AW	136	7	133-143	137.4	3.41	2.5	12	126-135	130.8	2.93	2.2
PW	136	7	127-143	134.6	5.03	3.7	12	125-139	132.2	4.30	3.3
SB	114	7	114-125	117.6	3.60	3.1	12	107-118	113.3	3.68	3.2
MSA	91	7	85-92	89.3	2.63	2.9	12	82-95	89.8	3.74	4.2
ASB	149	7	144-153	148.1	3.58	2.4	12	139-151	145.8	3.19	2.2
PSB	46	7	40-46	42.0	2.08	5.0	12	38-45	40.6	2.39	5.9
L	195	7	184-195	190.1	4.56	2.4	12	182-192	186.3	2.87	1.5
W	176	7	172-178	175.0	2.31	1.3	12	162-170	165.5	3.26	2.0
AP	61	7	59-62	60.6	3.21	5.3	12	59-67	63.9	2.71	4.2
SA	31	7	31-34	33.3	2.36	7.1	12	31-40	34.5	2.81	8.2
SP	34	7	27-34	29.9	2.61	8.7	12	25-34	31.5	2.39	7.6
AM	45	7	44-48	45.6	1.27	2.8	6	38-45	43.3	2.73	6.3
AL	53	7	47-57	52.3	3.20	1.9	12	44-56	48.2	3.90	8.1
PL	82	7	80-93	84.0	5.57	6.7	12	77-93	84.2	5.01	5.9
AMB	47	7	43-48	45.9	1.77	3.9	11	38-46	42.7	2.15	5.0
SE	75	7	60-73	66.4	5.80	8.7	10	62-77	70.0	4.67	6.7
PLN	42	7	40-46	43.4	2.30	5.3	11	38-47	42.9	2.43	5.7
PSL	74	7	71-78	74.0	2.16	2.9	11	69-74	72.2	1.89	2.6
PSW	164	7	159-166	162.9	2.91	1.8	12	152-164	157.1	3.20	2.0
QW	53	7	50-58	53.4	2.51	4.7	12	43-55	50.1	4.36	8.7
QL	91	7	81-91	84.6	3.87	4.6	12	69-85	79.8	4.69	5.9
DS	77-160	7	144-160*	151.7*	6.78*	4.5*	12	141-158*	150.9*	6.13*	4.1*
MDS	80	7	75-82	81.0	2.89	3.6	12	68-90	77.8	7.28	9.4
PDS	160	7	144-160	151.7	6.78	4.5	12	141-158	150.9	6.13	4.1
AW/QW	2.57	7	2.33-2.72	2.58	0.131	5.1	12	2.31-3.07	2.66	0.222	8.4
PSL/PLN	1.76	7	1.58-1.88	1.71	0.103	6.0	11	1.59-1.83	1.69	0.0890	5.3
Fel	91	7	96-93	90.6	2.37	2.6	12	86-98	90.7	3.87	4.3
GeI	51	7	51-60	55.1	2.61	4.7	12	51-57	53.3	1.97	3.7
Til	82	7	78-82	81.6	4.47	5.5	12	82-90	84.4	2.61	3.1
Tal(L)	110	7	107-113	110.3	2.14	1.9	12	109-118	115.1	3.34	2.9
Tal(H)	54	7	29-34	32.0	1.73	5.4	12	26-30	27.6	0.996	3.6
Til/GeI	1.61	7	1.42-1.61	1.48	0.0678	4.6	12	1.49-1.64	1.59	0.0478	3.0
FelI	77	7	75-77	76.1	0.900	1.2	12	70-83	77.1	3.75	4.9
GeII	43	7	43-47	44.3	1.60	3.6	12	42-48	44.3	1.83	4.1
TilI	77	7	71-77	74.4	2.30	3.1	12	73-82	77.2	2.95	3.8
TalI(L)	96	7	95-99	96.7	1.38	1.4	11	95-104	100.5	2.94	2.9
TalI(H)	26	7	25-27	25.9	0.690	2.7	12	22-25	23.1	0.996	4.3
TilI/GeII	1.79	7	1.57-1.79	1.68	0.0819	4.9	12	1.52-1.85	1.74	0.0844	4.8
FelII	83	7	82-85	83.1	1.21	1.5	12	82-92	85.8	2.89	3.4
GeIII	46	7	46-51	47.6	1.90	4.0	12	48-53	48.8	2.82	5.8
TilII	93	7	88-95	90.7	2.81	3.1	12	87-96	92.3	2.83	3.1
TalII(L)	102	7	93-107	101.3	4.50	4.4	12	93-111	103.4	5.25	5.1
TalII(H)	24	7	22-24	23.0	0.577	2.5	12	18-23	20.8	1.54	7.4
TilII/GeIII	2.02	7	1.78-2.02	1.91	0.0963	5.0	12	1.75-2.13	1.89	0.105	5.5
SA/SP	0.91	7	0.91-0.23	1.12	0.116	10.3	12	0.91-1.33	1.10	0.173	15.7
AW/AMB	2.89	7	2.83-3.16	3.00	0.139	4.6	11	2.89-3.52	3.11	0.191	6.1
QL/QW	1.72	7	1.41-1.72	1.59	0.108	6.8	12	1.45-1.93	1.60	0.164	10.2
PSW/QW	3.09	7	2.74-3.18	3.05	0.146	4.8	12	2.82-3.63	3.16	0.270	8.6
MA/AP	1.61	7	1.48-1.62	1.66	0.128	7.7	12	1.43-1.71	1.51	0.910	5.8

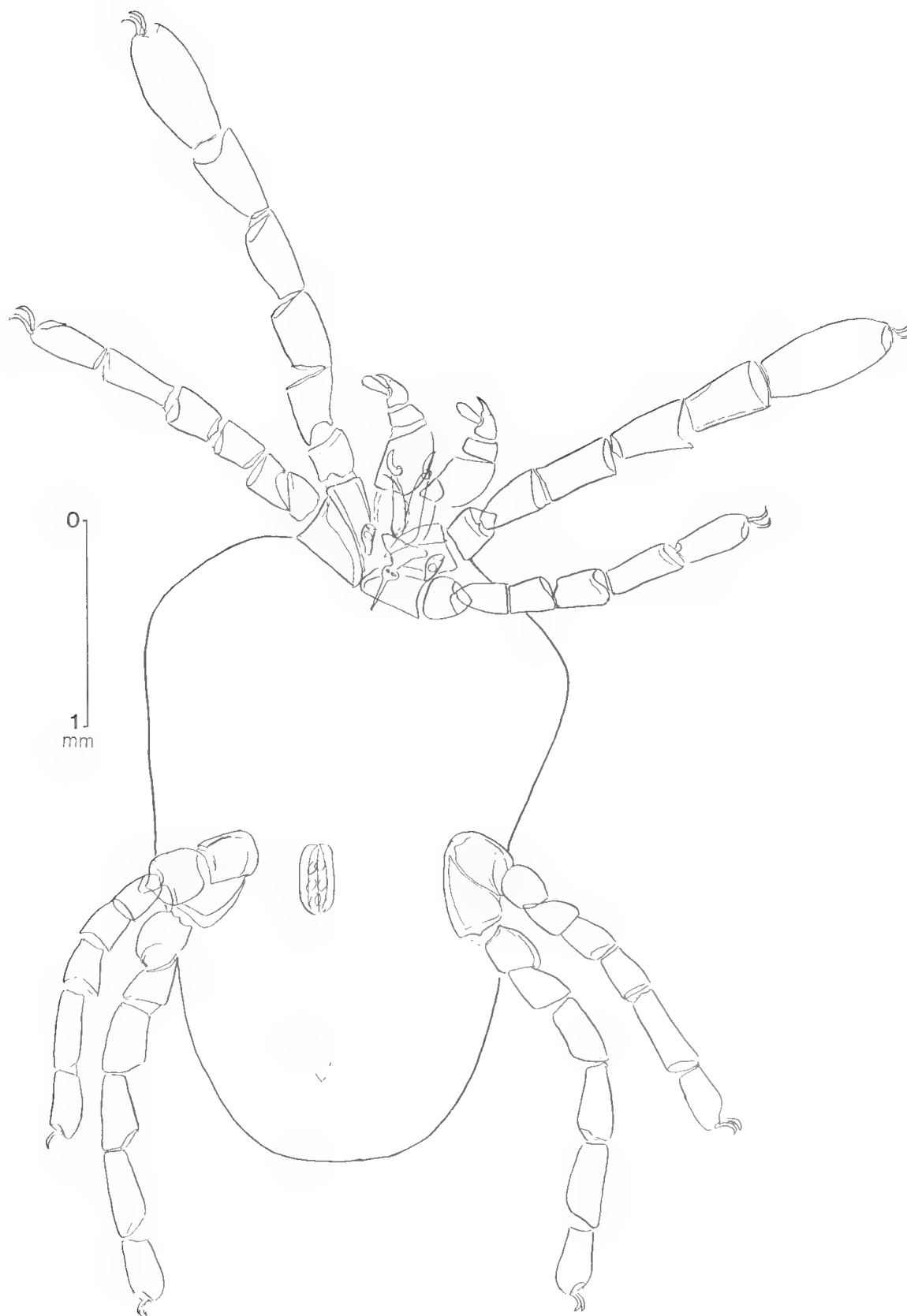


FIGURE 3. *Paratrombium australe* sp. nov., adult female, paratype, in transparency, setae omitted.

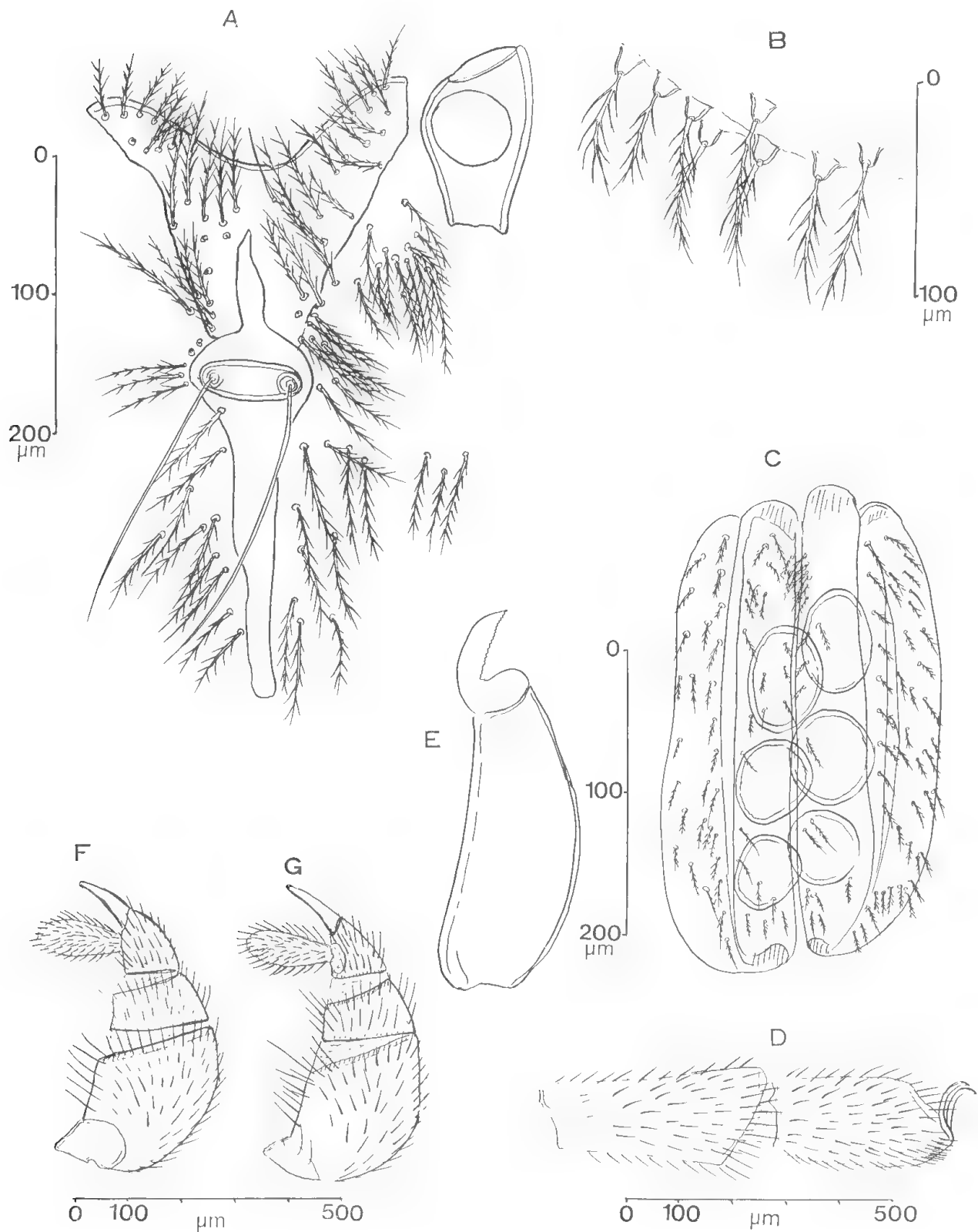


FIGURE 4. *Paratrombium australe* sp. nov., adult female, paratype. A, Crista and adjacent structures. B, Posterior dorsal idiosomal setae. C, External genitalia. D, Tibia IV and tarsus IV. E, Palp, dorsomedial aspect. F, Palp, ventrolateral aspect. (Each to nearest scale.)

across, terminal.

Dorsum of idiosoma thickly invested with pointed, tapering, well setulose setae (Fig. 4B).

Metric data as in Table 2.

Venter of idiosoma with setation similar to dorsal. External genitalia (Fig. 4C) oblong in outline, with rounded angles, 375 long by 220 wide; valves carry numerous setulose setae; genitalia with three pairs of subequal acetabula; anterior acetabulum oval, 82 x 55, middle oval

73–80 x 60–65, posterior near-circular, 65 x 45 and 60 x 58. Anus about 160 long by 60 wide.

Legs shorter than idiosoma; lengths (trochanter to claw tips: I 2665, II 1850, III 1865, IV 2270. Legs thickly invested with pointed, setulose setae. Tarsal claws smooth, falciform, about equal in size over legs I–IV.

Gnathosoma: chelicerae (Fig. 4E) robust, bases 230 long by about 110 wide (combined). Cheliceral digits falciform, 86 long, with fine dorsal denticles. Palpi (Fig. 4F,G) robust, all segments heavily invested with pointed, setulose setae. Palpal tibia with blunted odontus, but without paradonts or spinisetæ. Palpal tarsus elongate-ellipsoid, 170 long by 75 wide, over-reaching odontus.

TABLE 2. Metric data of *Paratrombium australe* sp. n., adults (CL = crista length; VW = vomer width).

Character	Described specimen ACB294A	Specimen ACB585A
CL	468	—
VW	256	331
ASB	222	229
PSB	246	—
SB	62	66
SE	c. 230	275
EPL	155	195
EPW	83	85
MDS	70–100	c. 80
PDS	70–100	c. 100
GeI	440	540
TiI	485	540
TaI(L)	684	735
TaI(H)	275	324
TiI/GeI	1.08	1.00
TaI(L)/TiI	1.43	1.36
TaI(L)/TaI(H)	2.48	2.27
GeII	310	360
TiII	410	480
TaII(L)	410	490
TaII(H)	175	180
TiII/GeII	1.32	1.33
TaII(L)/TiII	1.02	1.02
TaII(L)/TaII(H)	2.52	2.72
GeIII	297	333
TiIII	441	490
TaIII(L)	345	440
TaIII(H)	180	180
TiIII/GeIII	1.48	1.47
TaIII(L)/TiIII	0.78	0.90
TaIII(L)/TaIII(H)	1.92	2.44
GeIV	425	490
TiIV	454	684
TaIV(L)	367	440
TaIV(H)	184	209
TiIV/GeIV	1.07	1.40
TaIV(L)/TiIV	0.81	0.64
TaIV(L)/TaIV(H)	1.99	2.11

Description of ovum

Colour red or pink; smooth, polished, spheroidal, about 300–350 long by 250 wide (estimated from egg-skins of ACB294 and ACB585).

Description of prelarva

Colour red; appearance normal (size not measured).

Etymology

The specific name *australe* is an adjective, signifying that all specimens described originated in southern Australia (in fact, a limited area in South Australia).

Remarks

Table 2 gives the metric data of two adult females of *P. australe*, both of which produced ova which hatched to larvae, and used in the metric data of Table 1. See below on the discussion of the taxonomy of the adults of *Paratrombium*.

Biology

Two adult females of *P. australe* have been captured in the field, ACB294A and ACB585A, from which larvae were reared experimentally. In addition, batches of ova have been collected in the field, from which larvae of *P. australe* emerged. Details of these successful rearing experiments are as follows.

Experiment ACB294: Two adult mites were captured in close proximity on 12.x.1947. The larger one was the female ACB294A, and the smaller one ACB295 (assumed to be a male), from among damp bark in eucalypt forest (now the Nixon-Skinner Reserve). They were placed

together in a small tube with some damp soil from the site of capture.

On 17.x.1947 I recorded 'The female mite is resting on the cork, its abdomen somewhat shrunken. The male mite is resting on the glass, alongside the female, its front legs touching the front legs of the female. Not in coitus. On the damp bark is a large mass of light orange-red eggs, some hundreds. [They are] smooth, spheroidal, polished. The volume of the eggs is about twice the volume of the female! Yet they are so obvious as a body that they have obviously been laid by the large mite. Eggs are of uniform colour throughout the mass. Even if the smaller mite is not a male, none the less the eggs belong to the larger mite.'

On 26.x.1947 it was recorded that no further ova had been laid, and the ova remained undifferentiated. The smaller mite had been seen over the previous few days mounted on the back of the female.

On 2.xi.1947 the adults appeared healthy. A few ova were showing the 'earliest signs of colour differentiation', i.e. one side darker, the other lighter. There were a few mould filaments on the ova.

On 9.xi.1947 the ova were not further differentiated, and no further ova had been laid. The smaller mite was immobile, probably dead. On 14.xi.1947 the ova had become irregular in shape, and were recorded as containing developing legs. The smaller mite became mouldy, and was removed from the tube and preserved. The female mite was recorded as 'sluggish'.

Thereafter the deutova ('eggs') were observed daily. The developing legs became more prominent, and the eye spots developed. On 29.xi.1947 several larvae emerged; seven were mounted. On 30.xi.1947 a further group of larvae (about 20) had emerged. The adult female remained alive, but was not parasitized by the larvae; on 5.xii.1947 her movements were uncoordinated, and by 9.xii.1947 she had died. All larvae had emerged by 9.xii.1947, and were recorded as active and healthy. Their strongly positive phototropism (to both suffused natural and artificial (tungsten) light) allowed batches to be transferred to other tubes in efforts to find suitable arthropod hosts. As possible hosts small beetles, a mantispa, various Diptera, Jassidae (Hemiptera) and an immature locust were offered. Of these, the larvae attached only to the mantispa.

Experiment ACB585: A large adult was captured running across the ground on

30.viii.1953, and placed in a tube with some local soil. On 30.x.1953 (the next recorded observation) the adult was dead, and the tube contained also 'a loose aggregate of red eggs' in an advanced prelarva stage. A number of these emerged to larvae. The tube was allowed to dry out, and the adult and larvae later mounted by standard procedures.

Experiment ACB546: A batch of ova was collected from soil on 27.x.1951, and placed in a small tube with some local soil. A month later (25.xi.1951) they were recorded as pink, smooth and unshrunk. On 5.xii.1951 a few ova were observed to be in the prelarva stage 'but most are not'; all were unhatched; a few were mouldy. On 10.xii.1951 all had transformed to prelarvae; they were still in this stage on 21.xii.1951. On 23.xii.1951 'five larvae have hatched; others unhatched'.

On 25.xii.1951 'Tube is swarming with larval trombidids'; a few ova were still unhatched. I added a green-eyed lacewing (Neuroptera, Chrysopidae) to the tube. It promptly ate several larvae, and was not attacked by them.

A series of attempts to find suitable host arthropods was made. As before, this was made possible by the larvae being 'attracted to light'. Larvae successfully parasitized adults of *Musca domestica* L. (head, neck, thorax, abdomen, wings, legs), also other smaller Diptera, including a small hover fly (Syrphidae), as well as a small golden-green wasp, but not a thysanuran (Lepismatidae), a jassid (*Typhlocyba* sp., Hemiptera) or various other small Hemiptera. Although some of the larvae fed on their hosts and increased in size, none progressed to a later instar.

Two other batches of ova (ACB545 and ACB547) were collected at the same site, but in captivity became mouldy and did not transform to prelarvae.

In summary, ova are laid in October–November in the South Australian areas studied. They develop into prelarvae in some weeks, and larvae emerge in November–December. No larva has been captured ectoparasitic on an arthropod in the field, but experimentally they will parasitize Diptera, small Hymenoptera and a species of Mantispidae.

Paratrombium lindsayi sp. nov
(Figs. 5, 6A–F, 7, 8A–F)

Material examined

Holotype. South Australia: Glenunga,

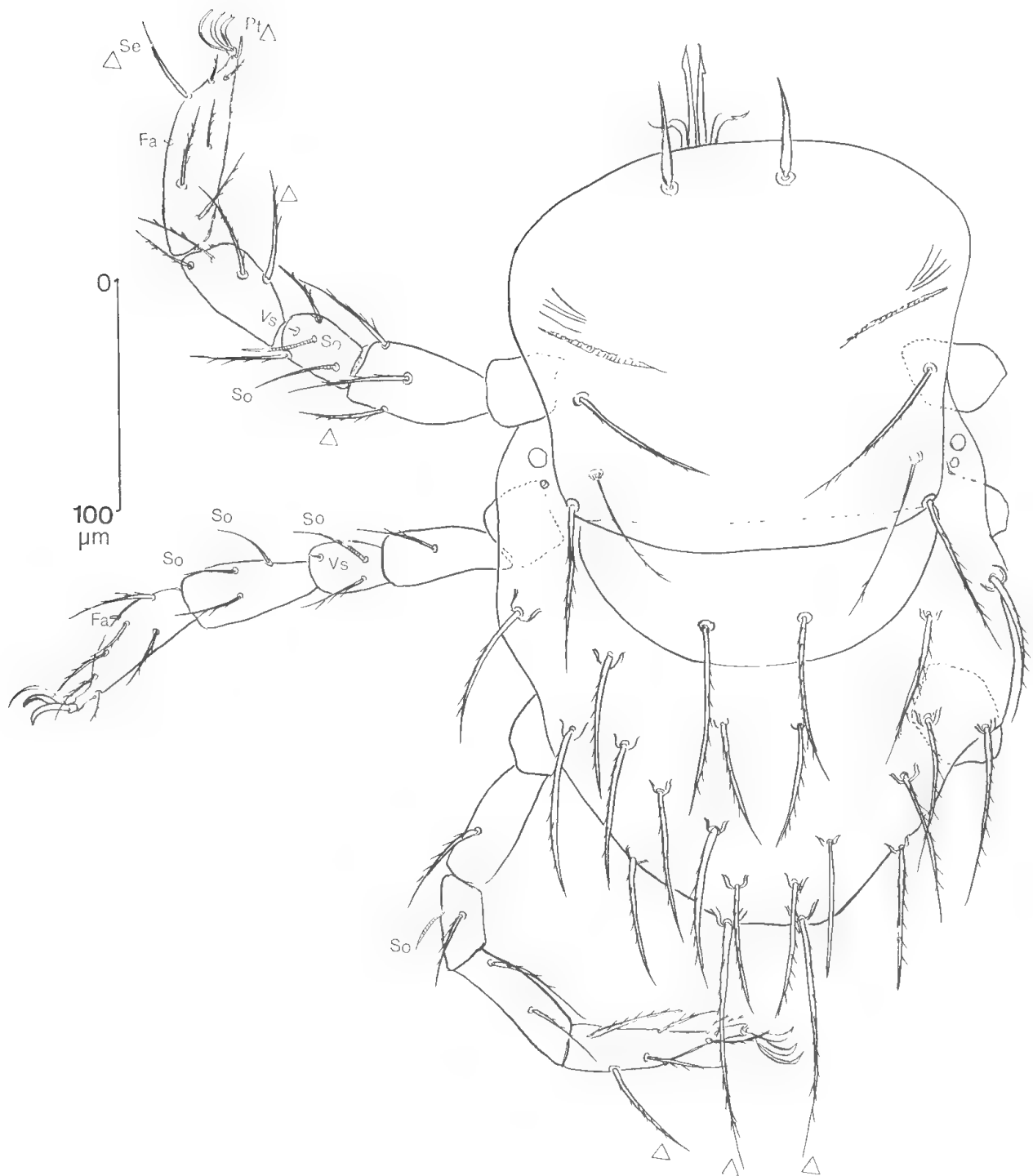


FIGURE 5. *Paratrombium lindsayi* sp. nov., larva, holotype. Dorsal view, to standard symbols; on right, legs omitted beyond trochanters.

November, 1951, reared larva ACB549L3, reared from ova laid by ACB549A, A. Lindsay Southcott. SAM.

Paratypes. Same locality and collector, adult female ACB549A, 28.x.1951; reared larvae (as for holotype) ACB549L1, 2, 4–8. SAM.

Diagnosis of larva

Scutellum with two setae. Posterior claw of tarsus III not reduced. AM setae thickened, pointed, tusk-like. Medial coxala I with 27–28 digitations. Odontus strong, curved, with two diverging tines. Tritorostral setae curved, pointed,

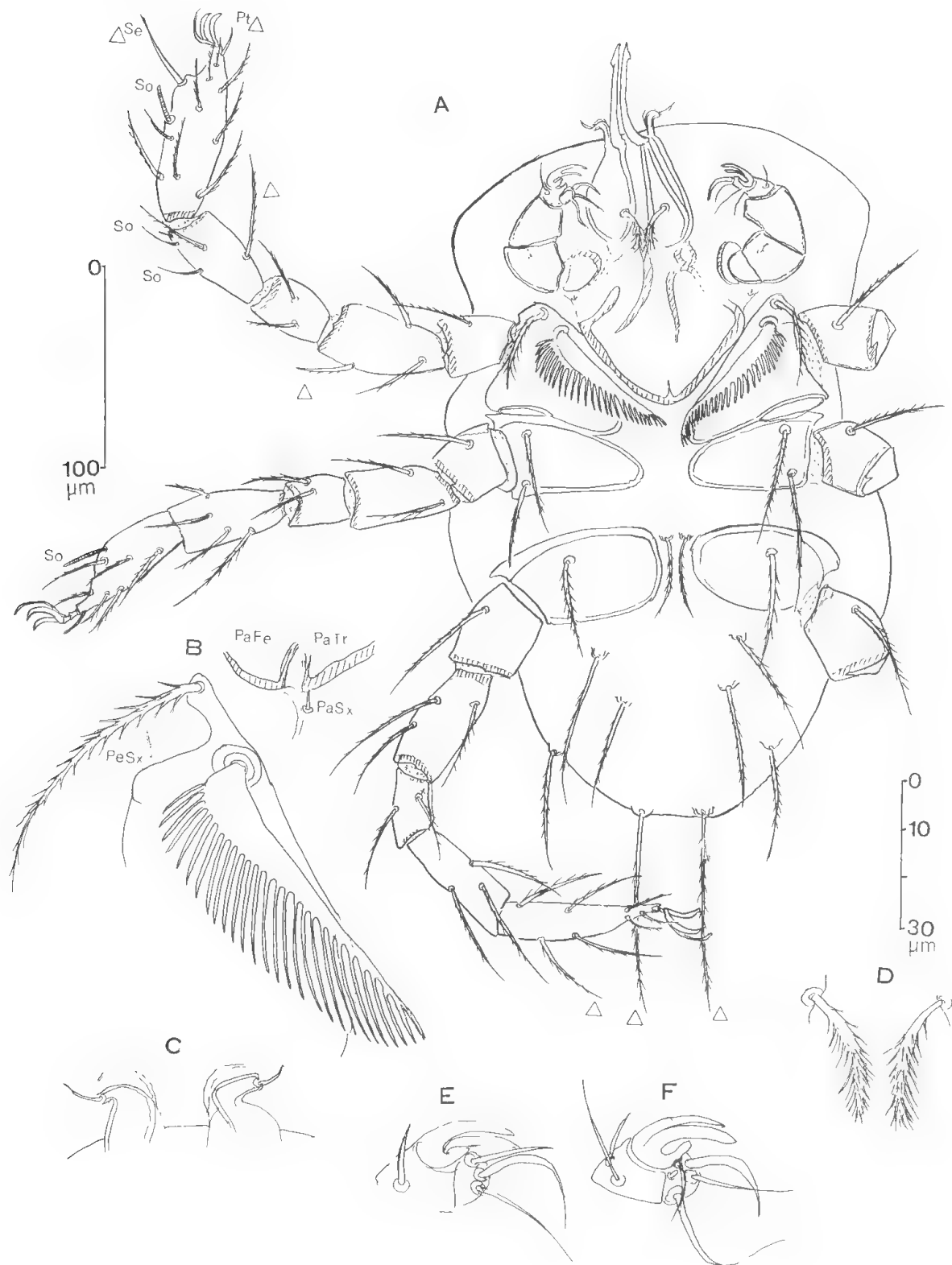


FIGURE 6. *Paratrombium lindsayi* sp. nov., larva, holotype, to standard symbols. A, Ventral view, on right legs omitted beyond trochanters. B, Medial coxala I and adjacent structures. C, Tip of rostrum and protorostral setae. D, Tritorostral setae. E, Palpal tibia and tarsus, dorsomedial aspect. F, Palpal tibia and tarsus, ventrolateral aspect. (PaFe palpal femur; PaTr palpal trochanter; PaSx palpal supracoxala; PeSx pedal supracoxala). (A to scale on left; B–F to scale on right.)

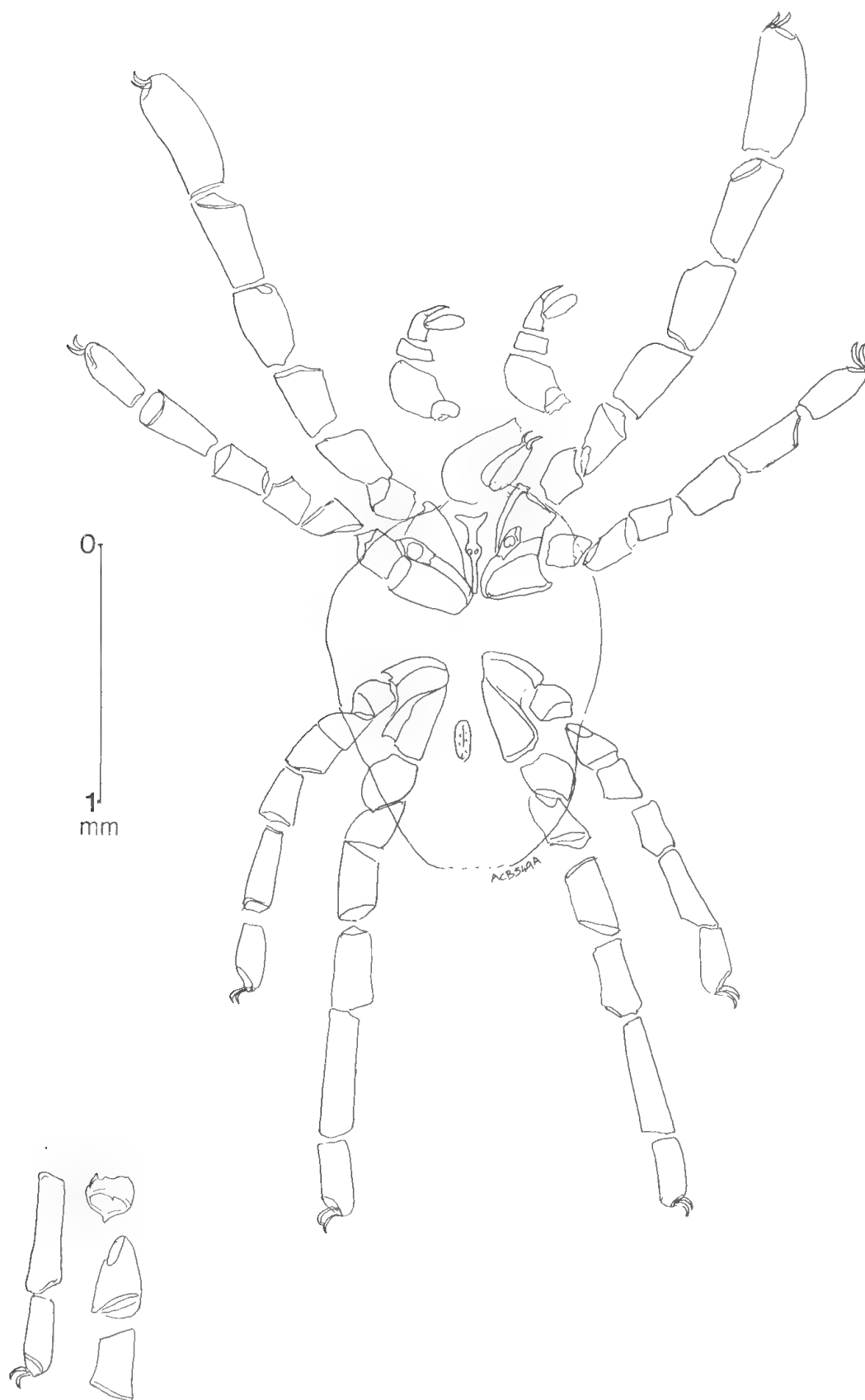


FIGURE 7. *Paratrombium lindsayi* sp. nov., adult female, paratype. In transparency; figure assembled from largely disarticulated pieces; inset: surplus fragments of another adult trombidoid present in the experimental tube (see text). (All to scale shown.)

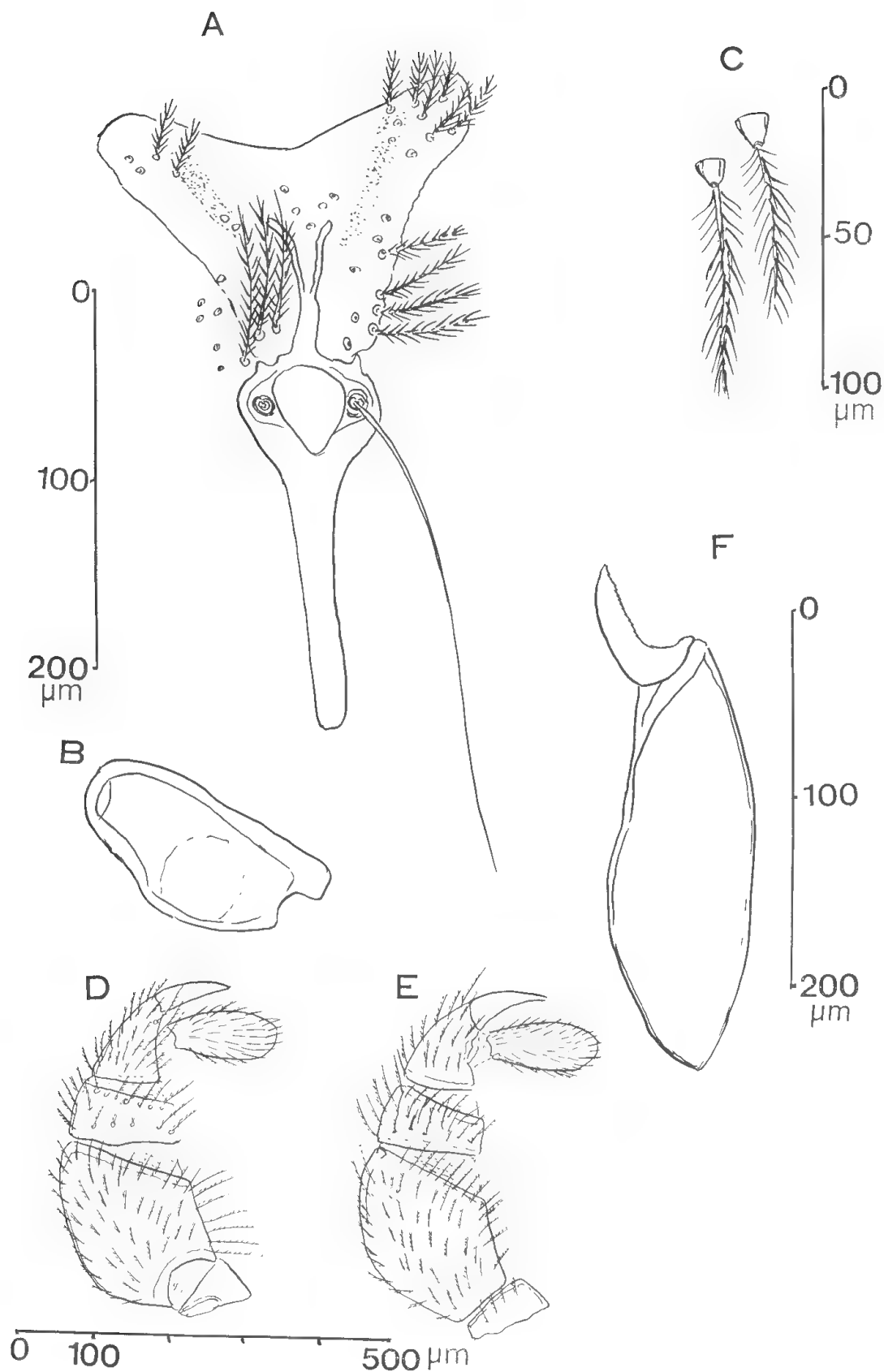


FIGURE 8. *Paratrombium lindsayi* sp. nov., adult female, paratype. A, Crista. B, Ocular peduncle. C, Two posterior dorsal idiosomal setae. D, Palp, dorsomedial aspect. E, Palp, ventrolateral aspect. F, Chelicera. (Each to nearest scale.)

with a leash of setules in distal half. MA/AP 1.84–2.29.

Diagnosis of adult

PDS to 80 µm long.

Description of larva, slide-mounted (from holotype, supplemented by paratypes) (Figs 5, 6A–F)

Colour in life red. Idiosoma ovoid, length 367, width 230; total length 417.

Dorsal scutum approximately square in outline, with rounded angles. Margins smooth, anterior margin convex, lateral margins weakly concave, posterior margin convex. Scutum finely porose, the only special markings being an oblique pleat laterally, anterior to middle of scutum, and a few curved striae anterior to it. AM setae smooth, pointed, tusk-like; AL and PL setae tapering, pointed, with a few slender, pointed setules. Sensillary setae filiform, with a few slender, distal setules.

Each eye pair near posterolateral border of scutum; anterior eye 11 across, posterior 8.

Metric data as in Table 3.

Scutellum transverse, with smooth margins; anterior border almost linear, posterior border strongly convex, lateral angles rounded; scutum porose, without special markings; scutalae similar to AL and PL scutalae of anterior dorsal scutum.

Dorsum of idiosoma behind scutellum with 20 setae, tapering, pointed, with a few lightly outstanding setules; setae arranged 2, 2, 6, 2, 4, 2, 2 (pygosomals).

Ventral surface of idiosoma (Fig. 6A): two setae (intercoxalae) between medial ends of coxae III, slender, tapering, setulose, 45 long, with long, pointed setules. Behind coxae III are setae similar to dorsals, 54–57 long, arranged 2, 4 (+ two pygosomals).

Legs of usual stature for genus; lengths (including coxae and claws) I 410, II 360, III 410. Coxa I with medial coxala I arising towards anterolateral angle, 71 long by 27 wide where widest, with *c.* 27 digitations (Fig. 6B), the proximal digitations arising almost at right angles to axis, distal ones arising more obliquely, all pointed; lateral coxala I arising close to anterolateral angle of coxa, 73 long, curved, pointed, well setulose with long setules; originating above posterior cornu of coxa-trochanteral joint a fine, pointed, simple seta (supracoxala), 15 long. Urstigma oval, 36 x 13, at posterolateral angle of coxa I. Coxa II with two pointed, setulose setae, each 55 long, anterior

arising near anterolateral angle of coxa, posterior near posterolateral angle. Coxa III with a similar seta, 58 long. Leg setae pointed, setulose. Scobalar formula (legs I, II, III): Fe 5, 4, 4, Ge 4, 3, 3, Ti 5, 5, 5.

Leg specialized setae: SoGel.24ad(42), SoGel.50ad(33), VsGel.77pd(*c.* 7), SoTil.54d(24), SoTil.81d(24), VsTil.93pd(*c.* 7). SoGelI.45p(45), VsGelI.81pd(7) SoTilI.21d(34), SoTilI.50pd(25). SoGelII.32d(40).

Tarsus I with SoTal.56d(25), FaTal.55ad(1), SeTalI.78d(43) ('tectal eupathidala'), Pt 11 long. Tarsus II with SoTalI.48d(18), FaTalI.48pd(1). Tarsal claws and empodium as in *P. australe*.

Gnathosoma: chelicerae bases spindle-shaped, 73 long by 55 wide (combined); cheliceral digits slender, 58 long, with 'chisel end' 13 long. Protostralar setae (Fig. 6C) simple, curved, pointed, 8 long; deutrostrals absent; tritrostrals (Fig. 6D) curved, 32 long, with a brush of setules in distal 2/3. A minute, slender supracoxala, 7 long, behind posterolateral border of palpal trochanter (Fig. 6B). Palpal femur with slender, simple, pointed dorsal seta 13 long. Palpal tibia with three simple, slender, pointed setae. Odontus strongly curved, with two divergent tines. Palpal tarsus (Fig. 6E,F) with seven pointed setae, of which two are scythe-like; also a short peg-like projection, ?solenoidala.

Description of adult female (from paratype ACB549A, slide-mounted, largely disarticulated, but reconstituted from morphology and sizes of leg segments) (Fig. 7, 8A–F)

Colour in life red. Idiosoma more or less cordate, 1420 long by 1075 wide; length to tip of cheliceral blades 1480.

Crista (Fig. 8A) well-developed, with typical vomer spreading from anterior part; in its anterolateral part vomer carries well setulose setae 40–50 long; in its more posterior part setae are up to *c.* 80 long. Sensillary setae filamentous, originating from a well-developed boss.

Dorsum of idiosoma thickly invested with tapering, well setulose setae (Fig. 6C) Eye peduncles well developed, each with two eyes (Fig. 6B), one at middle of peduncle 64 wide, the other terminal, *c.* 64 wide.

Metric data as in Table 4.

Ventral surface of idiosoma with setation similar to dorsal. External genitalia and anus partly obscured in specimen.

Legs of normal trombidoid stature; leg lengths (trochanters to claw-tips; estimated from reconstituted specimen by fitting drawings): I

TABLE 3. Metric data of *Paratrombium lindsayi* sp. nov. larvae (*for maximum values).

Character	Holotype	n	range	mean	s. d.	c.v.
LN	22	8	18-24	21.5	2.07	9.6
MA	103	8	97-107	102.9	2.80	2.7
AW	157	8	151-162	156.6	3.46	2.2
PW	169	8	155-169	161.6	4.47	2.8
SB	141	8	132-142	137.4	3.46	2.5
MSA	93	8	91-95	92.5	1.31	1.4
ASB	146	8	140-149	146.3	3.92	2.7
PSB	40	8	40-48	43.8	2.60	6.0
L	186	8	184-196	190.0	5.10	2.7
W	212	8	205-217	211.6	4.21	2.0
AP	45	8	45-56	52.3	3.37	6.4
SA	39	8	34-39	35.6	1.77	5.0
SP	22	8	21-25	22.6	1.19	5.2
AM	40	8	40-51	44.4	3.46	7.8
AL	55	8	48-57	53.0	3.55	6.7
PL	80	8	77-82	78.6	1.92	2.4
AMB	54	8	49-59	54.1	2.95	5.4
SE	60	8	80-92	88.6	4.00	4.5
PLN	c. 35	8	27-38	35.1	4.02	11.4
PSL	c. 55	8	46-69	59.3	6.50	11.0
PSW	c. 189	8	176-192	182.3	6.18	3.4
QW	59	8	54-60	57.1	2.30	4.0
QL	82	8	77-83	80.0	2.39	3.0
DS	75-125	8	109-127*	117.8*	7.01*	5.9*
MDS	75	8	66-76	74.0	3.25	4.4
PDS	125	8	109-127	117.8	7.01	5.9
AW/QW	2.66	8	2.57-2.89	2.72	0.0997	3.7
PSL/PLN	c. 1.57	8	1.57-1.78	1.69	0.0614	3.6
FeI	74	8	69-77	73.9	2.59	3.5
GeI	45	8	42-48	44.3	2.19	4.9
TiI	70	8	66-73	70.0	2.83	4.0
TaI(L)	91	8	86-91	90.0	1.77	2.0
TaI(H)	29	8	26-31	28.9	1.46	5.0
TiI/GeI	1.56	8	1.47-1.74	1.59	0.100	6.3
FeII	62	8	59-64	60.9	3.09	5.1
GeII	40	8	35-40	36.6	1.51	4.1
TiII	62	8	58-63	60.4	2.07	3.4
TaII(L)	76	8	73-80	76.8	2.05	2.7
TaII(H)	22	8	20-23	22.1	1.13	5.1
TiII/GeII	1.55	8	1.55-1.75	1.65	0.060	3.7
FeIII	69	8	64-70	67.3	2.38	3.5
GeIII	44	8	37-45	41.4	2.50	6.1
TiIII	73	8	69-75	71.8	2.05	2.9
TaIII(L)	84	8	78-86	82.4	2.72	3.3
TaIII(H)	22	8	18-22	20.1	1.25	6.2
TiIII/GeIII	1.66	8	1.53-1.95	1.74	0.123	7.1
SA/SP	1.77	8	1.36-1.77	1.58	0.120	7.6
AW/AMB	2.91	8	2.68-3.16	2.90	0.169	5.8
QL/QW	1.39	8	1.28-1.50	1.40	0.0676	4.8
PSW/QW	3.20	8	3.00-3.40	3.19	0.119	3.7
MA/AP	1.87	8	1.84-2.29	1.95	0.150	7.6

TABLE 4. Metric data of *Paratrombium lindsayi* sp. nov., adult, compared with adult *Paratrombium nynganense* (Hirst). (^A Data from Hirst (1928a). ^B Figures in parenthesis are derived from the disarticulated segments, after reconstitution and re-assessment of the largely disarticulated specimen. ^C Womersley (1934). CL = crista length; VW = vomer width).

Specimen	<i>Paratrombium lindsayi</i> ACB549A ^B	<i>Paratrombium nynganense</i>
Character		
CL	352	
VW	195	
ASB	165	
PSB	187	
SB	50	
SE	210	
EPL	128	
EPW	75	
MDS	—	
PDS	75–80	65 ^C
Gel	(373)	
Til	(432)	260 ^A
Tal(L)	(565)	350 ^A
Tal(H)	(203)	120 ^A
Til/Gel	(1.16)	
Tal(L)/Til	(1.31)	1.35 ^A
Tal(L)/Tal(H)	(2.78)	2.92 ^A
Gell	(245)	
TilI	(360)	
TalI(L)	320	
TalI(H)	139	
TilI/Gell	(1.47)	
TalI(L)/TilI	(0.89)	
TalI(L)/TalI(H)	2.30	
GellI	(237)	
TilII	(380)	
TalII(L)	(290)	
TalII(H)	(138)	
TilII/GellI	(1.60)	
TalII(L)/TilII	(0.76)	
TalII(L)/TalII(H)	(2.10)	
GellIV	(346)	
TilIV	(530)	
TalIV(L)	324	
TalIV(H)	140	
TilIV/GellIV	(1.53)	
TalIV(L)/TilIV	(0.61)	
TalIV(L)/TalIV(H)	2.31	

2145, II 1605, III 1405, IV 1900. Tarsal claws as described for *P. australe*.

Gnathosoma: combined chelicerae bases spindle-shaped, *c.* 200 long by 73 wide; cheliceral digits robust, 80 long, with fine, dorsal retrorse denticles (Fig. 8F). Palpi (Fig. 8D,E) robust, well covered with pointed, setulose setae; palpal tibial odontus as for *P. australe*, 130 long, without paradonts or spinisetae. Palpal tarsus 155 long by 64 wide, with numerous fine, setulose setae.

Description of Ovum

Red, spheroidal, smooth, size (estimated from cast ova skins) about 350 long by 250 wide.

Description of Deutovum

Colour red; dimensions not measured; no unusual features noted.

Etymology

The species is named for the collector, then aged 12 years.

Biology

Experiment ACB549: An adult female was captured on 28.x.1951, and confined in a small tube with some soil from the capture site. At the next observation, on 25.xi.1951, the adult was dead and the tube contained a 'Batch of red, smooth, spheroidal eggs'. On 5.xii.1951 all ova had developed to the prelarva stage; a few were mouldy. On 10.xii.1951 all had emerged to larvae. On 11.xii.1951 it was recorded that the larvae tended to aggregate in groups. An adult lacewing (*Chrysopidae*) placed in the tube was not parasitized by the larvae. By 16.xii.1951 all larvae had died.

The adult had been left in the tube, and had decomposed, the legs being largely disarticulated. Adult and larvae were mounted by standard procedures. The legs of the adult were mostly in individual segments, which were mounted, later to be identified by shape and measurement. In the tube were five extra leg segments, two were of a conjoined tibia IV and tarsus IV, discrepant from the others, and three segments (trochanteral and femoral) not used in the metric data in Table 4. It is assumed that the original soil used was contaminated by extra leg segments of another trombidoid mite.

Comment on the taxonomy of *Paratrombium australe* and *P. lindsayi*

Larvae: The two reared populations of larvae of *P. australe* (ACB294 and ACB585) show similar

morphological features, and in addition the metric data show overlapping ranges in almost all of the dimensions measured, so that their specific identity need not be questioned.

In the case of the larvae of *P. lindsayi* there is almost no overlap of the dimension ranges with those of the two populations of *P. australe*. Thus the shield dimensions AW, PW, SB, AMB and PSL are significantly larger, while others, such as AP, SP, PDS and most leg dimensions are significantly smaller. Additionally, the medial coxala I of *P. lindsayi* has *c.* 27 digitations, while the medial coxala I of *P. australe* has 15–20 digitations.

Adults: As only two adults of *P. australe* and one of *P. lindsayi* from which larvae have been reared are available, conclusions based on general morphology and metric dimensions need to be more guarded, particularly as one female of *P. australe* was significantly larger than the other. Nevertheless in nearly all cases the dimensions of the adult females of *P. australe* were significantly larger than those for the female of *P. lindsayi*. There are also several differences in the various dimension ratios between the two species (see Tables 2 and 4).

The relations between these adults and other adults allotted to the genus are conjectural. Each of them can be placed in the key to the adults given by Womersley in 1934 (as *Caenothrombium*); the nearest fit being between *P. lindsayi* and *P. nynganense* (Hirst). Even so, the length of tibia I of *P. nynganense* (from Hirst (1928a)) is only 60% of that of *P. lindsayi*, and only 54% or 58% of that of *P. australe*, while the length given of the dorsal idiosomal setae by Womersley (1934) as 65 is significantly shorter than that of *P. lindsayi* (75–80). (See also the Remarks on post-larval *Paratrombium*, below.)

***Paratrombium curculionis* sp. nov.**
(Figs 9, 10A–F)

Material examined

Holotype. Queensland. Wongabel, September 1944, R. N. McCulloch, larva ACB1303, ectoparasitic on a weevil (Coleoptera, Curculionoidea).

Diagnosis of larva

Scutellum with two setae. Posterior claw of tarsus III not reduced. AM setae slender. Medial coxala I with 12–13 digitations. Odontus strongly curved, almost circular. SB < 150 µm. AW < 150 µm.

Description of larva (from holotype, slide-mounted)

Colour in life red. Idiosoma 300 long, 205 wide; total length to tip of cheliceral blades 335. Anterior dorsal scutum with smooth borders; anterior border with a slight central concavity (a presumed artefact of mounting); other borders convex except for a weak emargination near the posterolateral angles to accommodate eyes; posterolateral angles rounded. AM setae slender, curved, simple, pointed; AL scutalae stout, tapering, pointed, with a few distal setules; sensillary setae filiform, with a few slender, distal setules. PL scutalae (missing in specimen) arise at PL angles of scutum.

Each eye pair placed near posterolateral border of scutum; corneae circular, anterior 11 across, posterior 9.

Scutellum porose; margins smooth; anterior margin slightly convex; lateral and posterior margins convex; scutalae stout, moderately setulose.

Metric data as in Table 5.

Dorsal idiosomal setae behind scutellum about 20 in number; each seta arises from a small conical papilla; setae stout, blunt-ended, with slender setules in distal half; arranged 2, 2, 6, 4, 4, 2 (pygosomals).

Ventral surface of idiosoma: between coxae II two slender setae, 40 long, pointed, with slender distal setules. Behind coxae III about eight setae, similar to dorsals, 54–60 long, arranged 2, 4 (+ two pygosomals).

Legs of normal stature, short, lengths (including coxae to claws): I 330, II 315, III 335. Leg scobalae pointed, simple, except for a few distal setules. Coxa I stout, triangular, with rounded medial end, carrying a medial pectinate seta 42 long with *c.* 13 slender digitations, arising obliquely, the longest of these arising about 2/3 along coxala (Fig. 10B). Lateral coxala I arises near anterolateral angle of coxa, stout, pointed, curved, setulose, *c.* 55 long. Dorsally above the posterior cornu of the coxal joint a slender, pointed supracoxala, 16 long (Fig. 10D). Urstigma narrow, oval, 31 long by 8 wide, on posterolateral part of coxa I. Coxa II carries two stout, pointed, lightly setulose setae, anterior 64 long, posterior 55. Coxa III with a similar seta 58 long. Scobalar formula (legs I, II, III): Fe 5, 4, 4, Ge 4, 3, 3, Ti 5, 5, 5.

Leg specialized setae: SoGeI.32pd(40), SoGeI.45d(36), VsGeI.76pd(6), SoTiI.47d(25), SoTiI.78ad(24), VsTiI.83pd(6). SoGeII.25d(30), VsGeII.66d(9), SoTiII.31d(30), SoTiII.69d(18). SoTiIII.30p(40).

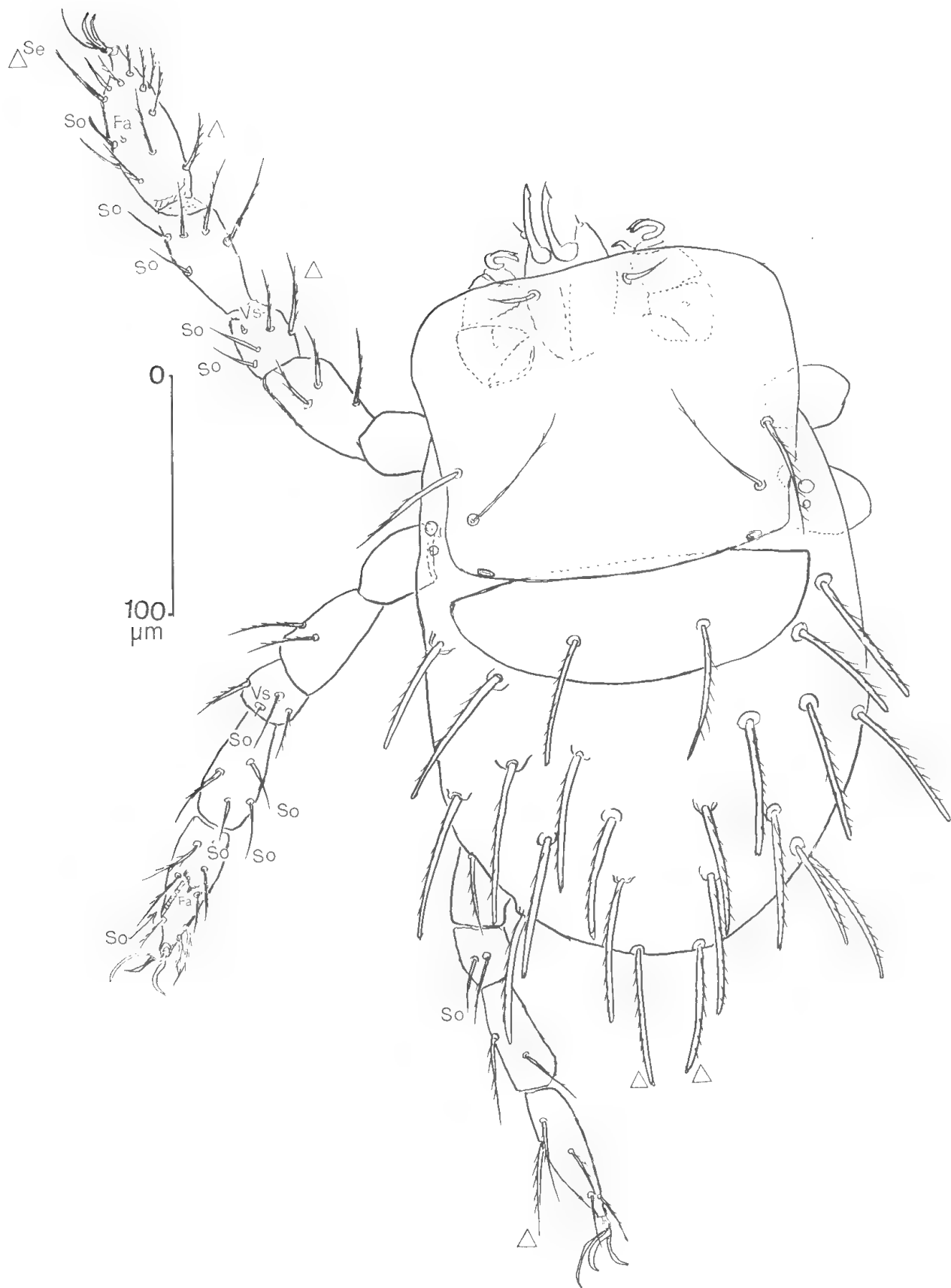


FIGURE 9. *Paratrombium curculionis* sp. nov., larva, holotype. Dorsal view, to standard symbols; on right, legs omitted beyond trochanters.

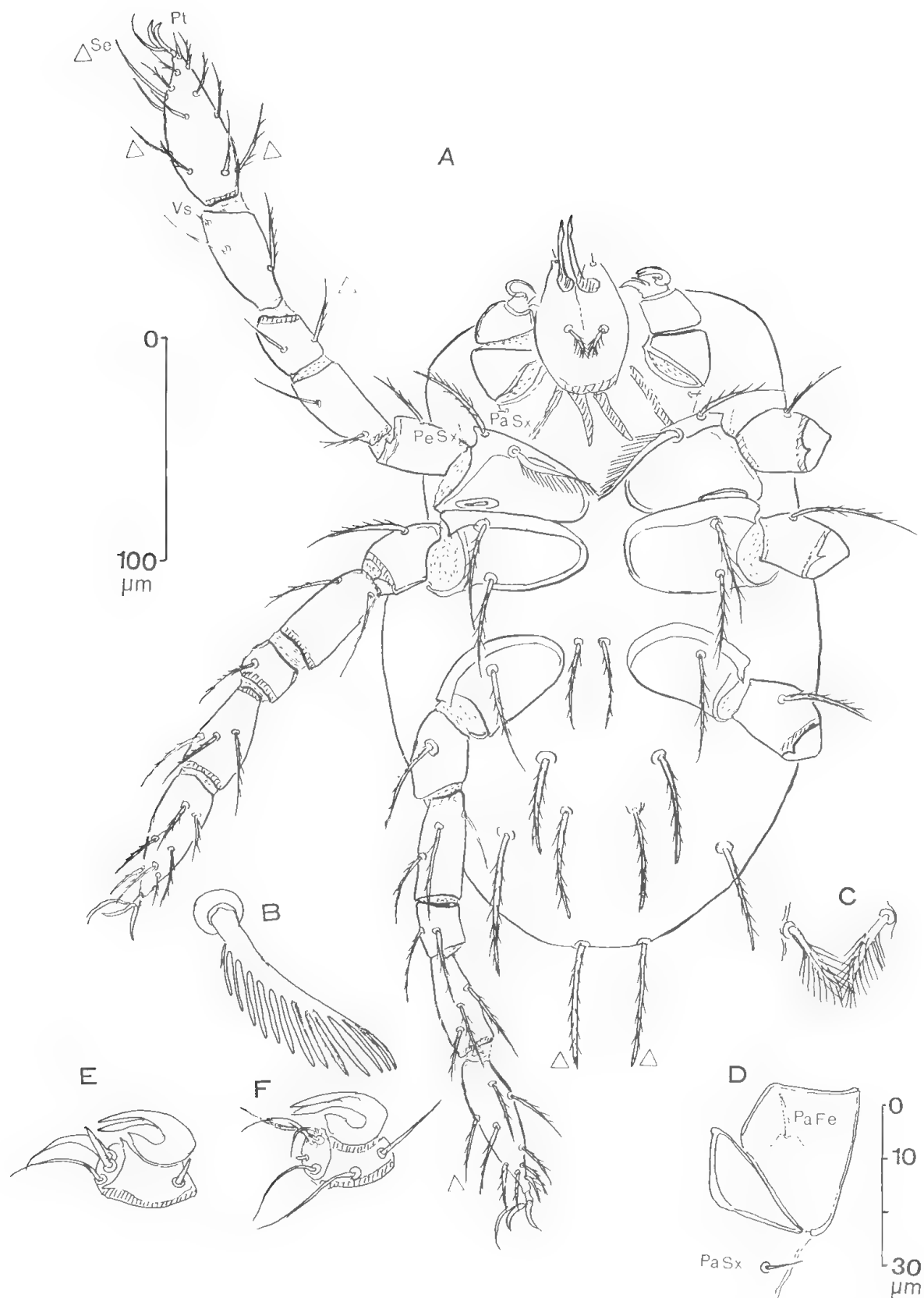


FIGURE 10. *Paratrombium curculionis* sp. nov., larva, holotype. A, Ventral view; on right, legs omitted beyond trochanters. B, Medial coxala I. C, Tritorostral setae. D, Ventral aspect of palpal femur and trochanter. E, Palpal tibia and tarsus, dorsomedial aspect. F, Same, ventrolateral aspect. (To standard symbols; additionally: PaFe palpal femoral, dorsal, shown in stipple in D; PaSx palpal supracoxala; PeSx pedal supracoxala, dorsal, shown in stipple in A.) (A to scale on left; B–F to scale on right.)

TABLE 5. Metric data for holotypes of *Paratrombium curculionis* sp. nov. and *Paratrombium anemone* sp. nov. (larvae)

Character	<i>Paratrombium curculionis</i>	<i>Paratrombium anemone</i>
LN	15	23
MA	82	87
AW	129	144
PW	110	144
SB	122	123
MSA	68	68
ASB	109	110
PSB	33	45
L	142	155
W	160	167
AP	38	38
SA	23	23
SP	18	21
AM	18	27
AL	42	55
PL	—	73
AMB	39	34
SE	64	—
PLN	28	18
PSL	53	36
PSW	149	160
QW	56	53
QL	62	82
DS	66–68	66–71
MDS	66	66
PDS	68	71
AW/QW	2.30	2.72
PSL/PLN	1.89	2.00
FeI	57	66
GeI	31	36
TiI	57	59
TaI(L)	74	84
TaI(H)	28	25
TiI/GeI	1.84	1.64
FeII	52	62
GeII	26	33
TiII	46	57
TaII(L)	66	69
TaII(H)	23	23
TiII/GeII	1.77	1.73
FeIII	57	66
GeIII	29	34
TiIII	54	68
TaIII(L)	70	76
TaIII(H)	21	19
TiIII/GeIII	1.86	2.00
SA/SP	1.28	1.10
AW/AMB	3.31	4.24
QL/QW	1.11	1.55
PSW/QW	2.66	3.02
MA/AP	2.16	2.29

Tarsus I with SoTaI.47d(20), FaTaI.48ad(3), SeTaI.69d(40), Pt 11 long. Tarsus II with SoTaII.43–.44d(20), FaTaII.48–.40pd(2) Claws of all tarsi smooth, falciform, equal; empodium over-reaching claws.

Gnathosoma: chelicerae compact, bases about 55 long by 45 wide (combined); cheliceral digits slender, curved, 39 long, with terminal blade 12 long. Protorostral setae simple, pointed, 7 long. Deutorostrals absent. Tritorostral setae Fig. 10C) curved, 16 long, with brush-like expansion of setules in distal half. Behind posterolateral border of palpal trochanter a slender, simple supracoxala, 8 long. Palpi stout. Palpal femoral seta simple, pointed, 10 long. Palpal tibia (Fig. 10E,F) conical, with three simple, pointed setae; odontus strongly curved, almost forming a circle. Palpal tarsus with seven pointed setae, two deflexed. Palpal supracoxala posterolateral to palpal trochanter, simple, pointed, 8 long.

Etymology

The specific name *curculionis* is a noun in the genitive (Latin), signifying 'of a weevil' (host).

Paratrombium anemone sp. nov.

(Figs 11, 12A–E)

Material examined

Holotype. Papua New Guinea, Babiang, 19.xii.1944, R.V. Southcott, larva ACB267, caught free-living in damp soil. SAM.

Diagnosis of larvae

Scutellum with two setae. Posterior claw of tarsus III not reduced. AM setae slender, not tusk-like. Odontus almost straight, axial to palpal tibia. Tritorostral setae expanded, with several large blunted digitations. Medial coxala I with *c.* 17 digitations.

Description of holotype larva, slide mounted.

Colour in life red

Idiosoma *c.* 300 long by *c.* 200 wide; total length to tip of cheliceral blades *c.* 320.

Anterior dorsal scutum more or less oblong, finely porose, without special markings. Margins smooth; anterior margin with shallow median indentation (possibly an artefact of mounting); shape of lateral margins indeterminate from probable distortion in mounting; posterior margin weakly convex. AM setae slender, simple, pointed. Other scutalae stronger, pointed, simple except for slight terminal setules. Sensillary setae missing in specimen.



FIGURE 11. *Paratrombium anemone* sp. nov., larva, holotype, to standard symbols; legs omitted on left. The specimen is somewhat distorted, and the pattern drawn of post-scutellar dorsal setae is somewhat interpretative.

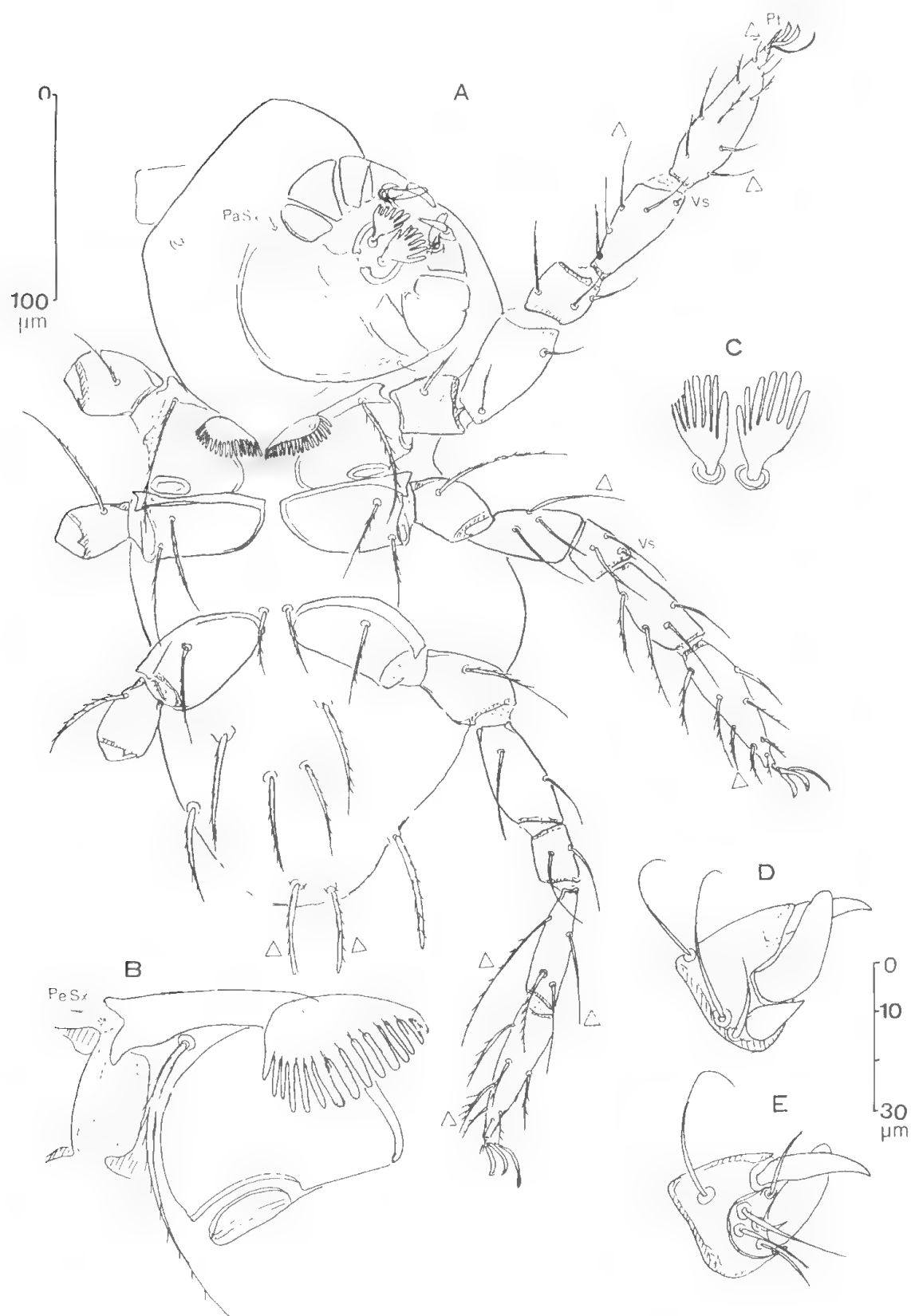


FIGURE 12. *Paratrombium anemone* sp. nov., larva, holotype, to standard symbols. A, Ventral view, legs omitted on left. The specimen is somewhat distorted, and the pattern drawn of hysterosomal setae somewhat interpretative; PaSx palpal supracoxala. B, Coxa I, ventral aspect, and adjacent structures; PeSx pedal supracoxala (dorsal), shown in stipple. C, Tritorostral setae. D, Palpal tibia and tarsus, dorsomedial aspect. E, Palpal tibia and tarsus, ventrolateral aspect. (A to scale on left; B–E to scale on right.)

Eyes near posterolateral border of scutum, anterior 9 across, posterior 7.

Scutellum porose, narrow, transverse; anterior border linear, anterolateral angles acute, at about 60°; posterior border convex; the two scutalae tapering, pointed, simple except for slight setules in distal half.

Metric data as in Table 5.

Dorsum of idiosoma behind scutellum with *c.* 19 setae, pointed or blunt-pointed, with slender, pointed setules; setae arise from hemispherical papules; precise arrangement uncertain from distortion of specimen.

Ventral surface of idiosoma: between coxae III two slender, pointed, lightly setulose setae, 45 long, arising from papules. Behind coxae III *c.* eight setae, arranged 2, 4 (+ 2 pygosomals); setae similar to dorsals, 70–75 long.

Legs of usual trombidoid larval stature; lengths (including coxae and claws): I 365, II 350, III 375. Coxa I (Fig. 12A) forms a quarter-circle with a projecting anterolateral articular piece. At about the anteromedial position medial coxala I arises, comma-shaped, 38 long by 21 wide, with a row of 16–17 blunt-ended digitations, coming off at about a right angle to the main axis; the digitations are longest at about the middle of the array (Fig. 12B). At about the anterolateral position a strong, pointed lateral coxala I, about 60 long, with fine, pointed setules. Above the anterior cornu of coxa I is a fine, pointed, simple supracoxala, 13 long. Urstigma 21 x 9 present, set in the posterolateral angle of coxa I. Coxa II with two setae, tapering, pointed, with slender setules; anterior seta 60 long, posterior 50. Coxa III with a similar seta, 62 long. Leg scobalae similar, with slender setules; scobalar formula (legs I, II, III): Fe 5, 4, 4, Ge 4, 3, 3, Ti 5, 5, 5.

Leg specialized setae: SoGeI.15d(46), SoGeI.31ad(53), VsGeI.85pd(5), SoTiI.54d(30), SoTiI.70d(22), VsTiI.84pd(7), SoGeII.34d(70), VsGeII.76ad(5), SoTiII.20d(38), SoTiII.53d(53), SoGeIII.25d(75).

Tarsus I with SoTaI.33d(31), FaTaI.45ad(3), SeTaI.68d(47), Pt 14 long. Tarsus II with SoTaII.37d(18), FaTaII.41pd(3). Tarsal claws falciform, smooth, equal over legs I–III; empodium of each tarsus slender, over-reaching the lateral claws.

Gnathosoma: chelicerae compact, bases *c.* 70 long by 50 wide (combined). Protorostral setae not identified. Deutorostrals absent. Tritorostrals (Fig. 12C): each seta expanded to a set of seven round-ended digitations; setae *c.* 27 long. Palpal femoral seta slender, pointed, simple, 16 long.

Palpal tibia with three simple, pointed setae (or four, anomalously), proximal; also a strong, pointed, undivided odontus, projecting axially. Palpal tarsus with two large, sclerotized ventromedial projections, evidently modified setae; proximal one short and conical, the larger one cucumber-shaped (see Fig. 12D,E), and reaching as far anteriorly to almost the tip of the odontus; also five fine, simple, pointed setae; no solenoidala detected. Palpal supracoxala slender, spiniform, 6 long.

Etyymology

The specific name *anemone* is a noun in apposition, of classical Greek origin, which refers to the zoophyte-like appearances of the tritorostral setae.

Remarks

Paratrombium anemone differs from other described larvae placed in the genus in having spreading, digitate tritorostral setae, and in detailed structure of the palpal tarsus. The latter has two large sclerotized projections, which are presumably modified setae. The more characteristic scobalae of the palpal tarsus appear normal in being slender, simple, pointed, but are without modification into scythe-like forms.

REMARKS ON POST-LARVAL *PARATROMBIUM*

Six species of *Paratrombium* have been correlated between larvae and adults by experimental rearing from ova laid by females; two European, two North American and two Australian. These rearings confirm the placing of *Paratrombium* in the Trombidiinae, and allow the corrections of generic placements of earlier authors of Australian adult Trombidiidae. Of those placed in *Caenothrombium* Oudemans, 1927 by Womersley (1934), after the earlier placement of *Caenothrombium miniatum* Womersley, (1934) in *Pollicotrombium* Southcott, 1986 as *P. miniatum* (Womersley) (see Southcott 1986), the following new combinations may be assigned:

Paratrombium album (Womersley, 1934: 204), comb. nov.,

P. augustae (Hirst, 1928b: 1032), comb. nov.,

P. crassum (Hirst, 1928a: 567), comb. nov.,

P. montivagum (Hirst, 1928b: 1027), comb. nov.,

P. nobile (Hirst, 1928b: 1932), comb. nov.,

P. nynganense (Hirst, 1928a: 566), comb. nov.,

P. rainbowi (Hirst, 1928b: 1031), comb. nov.,

P. sericatum (Rainbow, 1906: 158), comb. nov.,

P. splendidum (Hirst, 1928a: 566), comb. nov.,
P. taylora (Hirst, 1928b: 1034), comb. nov.,
P. torridum (Hirst, 1928a: 567), comb. nov.,
P. ventricosum (Hirst, 1928b: 1032), comb. nov.

Some of these species were synonymized by Womersley (1934), with little discussion; however, a key was provided.

One point of interest in adult chaetotaxy is that European *P. megalochirum* (Berlese, 1910) (see Berlese 1912) and *P. divisipili* (Feider, 1950)

(q.v.) have thickened dorsal idiosomal setae, while the North American adults described by Newell (1958), and the recorded Australian adults have slender, pointed dorsal idiosomal setae.

ACKNOWLEDGMENTS

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A NEW GENUS AND SPECIES OF AUSTRALIAN DYTISCIDAE (COLEOPTERA)

C. H. S. WATTS

Summary

Sekaliporus kriegi is described from Northern Australia. The new genus and species resembles *Tiporus* Watts and *Antiporus* Sharp (Hydroporinae), but differs from these genera by characters of the humeral angles of the elytera, the postcoxal lines and male protarsi and genitalia.

A NEW GENUS AND SPECIES OF AUSTRALIAN DYTISCIDAE (COLEOPTERA)

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Watts C. H. S. 1997. A new genus and species of Australian Dytiscidae (Coleoptera). *Records of the South Australian Museum* 29(2): 121–123.

Sekaliporus kriegi is described from Northern Australia. The new genus and species resembles *Tiporus* Watts and *Antiporus* Sharp (Hydroporinae), but differs from these genera by characters of the humeral angles of the elytra, the postcoxal lines and male protarsi and genitalia.

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Among some *Antiporus* specimens sent to me recently from the Australian National Insect Collection, Canberra were a series of specimens from the Northern Territory that did not fit any known species of *Antiporus* Sharp nor the related *Tiporus* Watts (Watts 1978; 1985; Brancucci 1984). These specimens had the fourth segment of the male protarsi absent (or greatly reduced) and the evenly punctate metatibia characteristic of the *Barrethydrus*/*Antiporus*/*Tiporus* group of Hydroporinae. They lacked the pronounced elytral grooving of *Barrethydrus*. The males had the strongly asymmetrical expansion of the protarsi typical of *Tiporus* but they more closely resembled *Antiporus* in the shape of the humeral angle of the elytron and in having four-segmented protarsi. Further study revealed other characters not found in either *Antiporus* or *Tiporus* or in any other Hydroporinae. These specimens are described here as a new genus and species.

Sekaliporus gen. nov.

A member of the Hydroporinae. Small, oblong oval, convex. Moderate to strong, even punctures throughout. Femora and tibiae punctate. Elytron with wide epipleura, narrowing progressively posteriorly, lateral edge of elytron and lateral edge of pronotum forming nearly continuous straight or slightly sinuate line in combination. Prothoracic process narrow, highly keeled, metacoxal lines well marked or even raised, close together, subparallel for most of their length. Midline of sternites appear somewhat raised or bulbous. Female with pro- and mesotarsi with very small fourth segment, well hidden in lobes of third segment. Male lacks sexual development of legs except for protarsi. Male protarsi with basal three segments markedly asymmetrical, posterior lobes

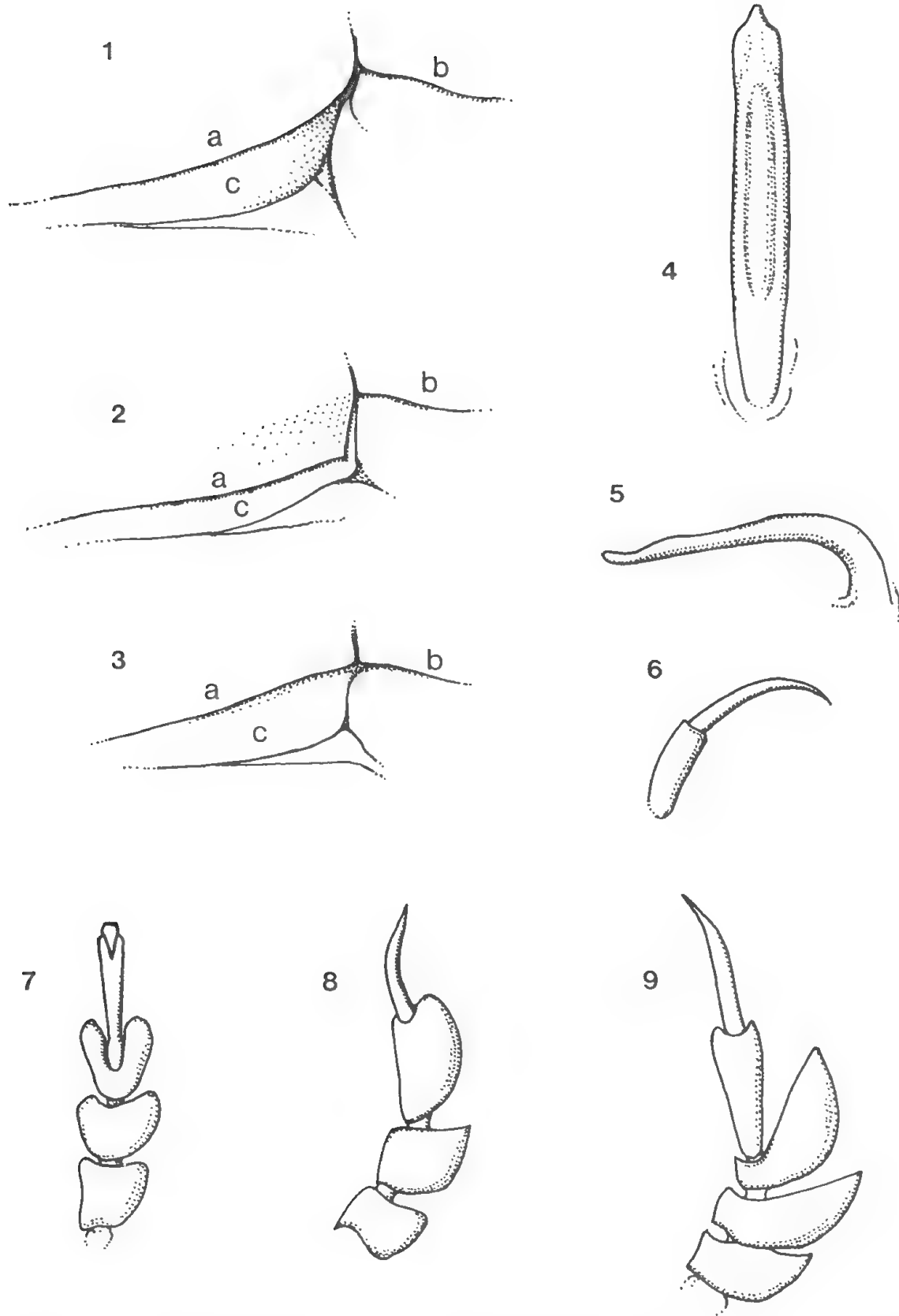
small, anterior lobes greatly expanded, seemingly lacking small fourth segment present in females. Single protarsal claw slender, elongate in only known species. Parameres flat, ribbon like, connect with basal piece of aedeagus only at anterior portion of aedeagus base.

Sekaliporus kriegi sp. nov.

(See Figs 1–9)

Description (number examined, 19)

Length 3.1–3.8 mm. Oblong-oval, convex, elytron extended posteriorly by subapical spine. Nitid, dark red-brown to black, head lighter, pronotum laterally and band across middle diffusely lighter; in many specimens, elytron with one or two subbasal, diffusely lighter patches and one subapical one variable in size, tip usually lighter, appendages a little lighter. Head finely and sharply punctured, punctures less than diameter of eye facets, most separated by more than their diameters, finely reticulate. Pronotum with larger punctures, but still smaller than eye facet, separated by about their diameter on disc, closer laterally, tendency to form longitudinal lines along posterior edge, finely reticulate. Elytra punctured as on pronotum, weak tendency for punctures to form into longitudinal rows anteriorly, denser and stronger apically, virtually lacking reticulation. Elytron weakly margined, margin moderately serrate towards apex, margin produced into well marked broad triangular spine close to apex. Ventral surface strongly and densely rugose - punctate. Prothoracic process narrow, strongly bent in lateral view, strongly keeled, constricted slightly between procoxae, metathorax narrowly raised (viewed ventrally) in middle behind mesocoxae, raised portion grooved in mid-line. Postcoxal lines raised, particularly in anterior



FIGURES 1–9. 1, Lateral view of humeral angle region of *Antiporus*, a = lateral edge of elytron, b = lateral edge of pronotum, c = epipleura; 2, Ditto *Tiporus*; 3, Ditto *Sekaliporus*; 4, Dorsal view of aedeagus of *S. kriegi*; 5, Lateral view of aedeagus of *S. kriegi*; 6, Lateral view of male proclaw of *S. kriegi*; 7, Ventral view of male right protarsus of *Antiporus femoralis*; 8, Ventral view of male right protarsus of *Tiporus undecimmaculatus* (Clark); 9, Ventral view of male right protarsus of *Sekaliporus kriegi*.

third, close together, subparallel, converging slightly in front, diverging slightly behind. Midline of sternites somewhat bulbous.

Male

Protarsi four-segmented, basal three segments strongly asymmetrical, with posterior lobes reduced in size and anterior lobes greatly expanded. First and second segments subequal, third segment twice length of second, anterior lobe nearly as long as narrow un-lobed apical segment. Single claw long and thin, virtually straight except for strong basal curve.

Female

Protarsi five-segmented, three basal segments weakly expanded, segments one and two moderately asymmetrical, third segment weakly asymmetrical; two simple claws.

Distribution

Known only from the type localities in coastal Northern Territory and the Kimberley.

Types

Holotype: Male '12°23'S, 132°56'E, 7km NW by N of Mt Cahill Crossing, East Alligator River, N.T. 9.vi.73, Upton and Feehan', in ANIC.

Paratypes: 1, '12°46'S 132°39'E, 12km NNW of Mt Cahill, N.T. 20.v.73, Matthews & Upton', in ANIC; 3, '12°23'S 132°56'E, 7 km NW by N of Mt Cahill Crossing, East Alligator River, N.T. 9.vi.73 Upton and Feehan', in ANIC; 1, '13°03'S 132°19'E, South Alligator River, N.T. 46km WSW of Mt Cahill. 20.v.73, Matthews & Upton', in ANIC; 3, '12°22'S 133°01'E, 6 km SW by S of Oenpelli, N.T. 30.v.73, E.G. Matthews', in SAMA; 4, same data but at light, 2 in SAMA, 2 in ANIC; 1, 'McArthur River, N.T. 16°39'S 135°51'E 80 km SW of Borroloola, 13.v.73. M.S. Upton', in ANIC; 1, '16°31'S 125°16'E CALM site 25/1 Synnot CK W.A. 17–20 June 1988 T.A. Weir, at light open forest', in ANIC; 2, '12°50'S 132°51'E 16km E by N of Mt Cahill N.T. 13.vi.73 Upton of Feehan', in ANIC; 1, '12° 52'S 132°, S by E Koongarra N.T. 15 km E of Mt Cahill.

12.vi.73 Upton & Feehan', in ANIC; 1, '12°31'S 132°54'E 9km N by E of Mudginbarry HS, N.T. 26.v. 73 at light, Upton & McInnes', in ANIC.

Relationships

Sekaliporus clearly belongs close to *Antiporus* and *Tiporus*. In overall shape, colour and punctuation it quite closely resembles *T. josepheni*. It differs from both these genera by having the postcoxal lines very close together and almost parallel and in the shape of the humeral angle of the elytron. In *Sekaliporus* the epipleuron is sharply bent inwards to accommodate the profemur to the same extent as in *Tiporus* but the edge of the elytron is not also bent sharply as in *Tiporus* and to a lesser extent in *Antiporus*, but remains in the same line as the edge of the pronotum. The characters of the male also set *Sekaliporus* apart. Except for the protarsi, the legs of the males are simple in the only known species whereas in all known species of *Tiporus* and all but one *Antiporus*, the legs of the male are modified in some way. The male protarsi are unique. All three basal segments are grossly asymmetrically expanded, as in *Tiporus* but not *Antiporus*. The protarsi are four segmented as in *Antiporus*, in contrast to *Tiporus* which has only three segments and lacks the slender apical segment [the single claw arises from the third segment]. The parameres in both *Tiporus* and *Antiporus* are generally shortish and broad, often almost bulbous. In *Sekaliporus* they are noticeably more elongate and ribbon like and appear to be differently attached to the basal piece although this will need to be confirmed by careful dissection when more specimens become available.

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THE ABORIGINAL COSMIC LANDSCAPE OF SOUTHERN SOUTH AUSTRALIA

PHILIP A. CLARKE

Summary

This paper provides an overview of recorded accounts of Aboriginal beliefs from southern South Australia concerning the cosmos. This study is restricted to discussing a pre-European system of beliefs. It further develops concepts about Aboriginal relationships to space as discussed by Clarke (1991a). Star maps are provided for the Adelaide and Lower Murray areas.

THE ABORIGINAL COSMIC LANDSCAPE OF SOUTHERN SOUTH AUSTRALIA

PHILIP A. CLARKE

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This paper provides an overview of recorded accounts of Aboriginal beliefs from southern South Australia concerning the cosmos. This study is restricted to discussing a pre-European system of beliefs. It further develops concepts about Aboriginal relationships to space as discussed by Clarke (1991a). Star maps are provided for the Adelaide and Lower Murray areas.

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INTRODUCTION

In the mythologies recorded by the ethnographic sources for southern South Australia, there is frequent mention of Aboriginal beliefs concerning the origin of various cosmic bodies and their relationships to ancestral beings, both in the heavens and on earth. Many of the ancestral spirits that were considered to have been involved in the creation of the world, ended up in the sky. The present paper assembles information on the heavens and discusses how it was organised in the pre-European systems of belief. Although atmospheric properties, such as clouds, wind, rain, etc., are also clearly related to Aboriginal beliefs about the regions above them, this paper focuses chiefly on astronomical traditions.

The data presented in this paper is historical, recorded from Aboriginal people who had lived in the southern districts prior to and during the early phases of European colonisation in South Australia. The sources provide a fragmentary record from observers who were generally not privy to insider views of the indigenous cultures. Much of the material available consists of the observations from Europeans chiefly concerned with the setting up of colonial social structures, such as the legal system and Aboriginal welfare. Teichelmann, Schurmann, and Meyer were German missionaries who actively recorded the culture of their intended Aboriginal converts. Their reliability as sources comes through personal knowledge of the languages involved. Nevertheless, some caution is necessary because the missionaries were looking for religious ideas to assist in translating Christian terms. Their

publications, which were published between 1840 and 1846, were essentially studies of Aboriginal language and religion (Teichelmann & Schurmann 1840; Teichelmann 1841; Meyer 1843; 1846; Schurmann 1844; 1846). The ethnographic dominance of these recorders was such that other sources for southern South Australia, such as Gell (1842), Wilhelmi (1860), and Taplin (Journals; 1874; 1879) acknowledged them as major sources of primary data. The main account provided by Wyatt (1879) stemmed in part from material he gathered while preparing a report in 1838 concerning whether Aboriginal religion provided for beliefs in 'God' and an afterlife, upon which an oath in a court of law could be based.¹ The ethnography of Moorhouse (1843; 1846) was compiled by him in his official capacity of Aboriginal Protector. Although all ethnographic accounts were written by men, in the case of the missionary, Taplin, there is evidence showing that he incorporated the observations and views of his wife.² These observers had a practical interest in Aboriginal religion and traditions, in spite of the fact that their records were compiled before the development of anthropological theory.

During the twentieth century, much ethnographic data from southern South Australia was collected and published by Tindale (1935; 1936; 1937; 1938; 1939; 1940; 1941; 1974; 1987; Tindale & Mountford 1936; Tindale & Pretty 1980), the Curator of Anthropology at the South Australian Museum.³ His data chiefly came from elderly Aboriginal informants he interviewed from the late 1920s onwards. His Aboriginal sources included John Wilson ('Sustie'), Reuben Walker, Amelia Savage ('Ivaritji'), Henry Mason

(‘Mengoan’), Robert (‘Joe’) Mason, Mary (‘Grannie’) Unaipon (‘Ngunaiponi’), and Clarence (‘Clarrie’) Long (‘Milerum’). The Aboriginal people who worked with the social anthropologists, Ronald and Catherine Berndt (Berndt 1940; Berndt & Berndt 1993), included Barney Warrior (‘Waria’), Albert Karloan (‘Karlone’), Mark Wilson (‘Thralrum’), and Margaret (‘Pinkie’) Mack. The mythology upon which the folklorist, Smith (1930), based his

Aboriginal stories was primarily gathered by his Ngarrindjeri informant, David Unaipon.⁴ As a body of literature these twentieth century ethnographic sources are essentially attempts to record a pre-European culture as it would have been experienced to the generations preceding that of their informants. In contrast to studies that described a living situation, these are studies of ‘memory culture’ (Berndt 1974: 22, 25; Tonkinson in Berndt & Berndt 1993: xix). A more

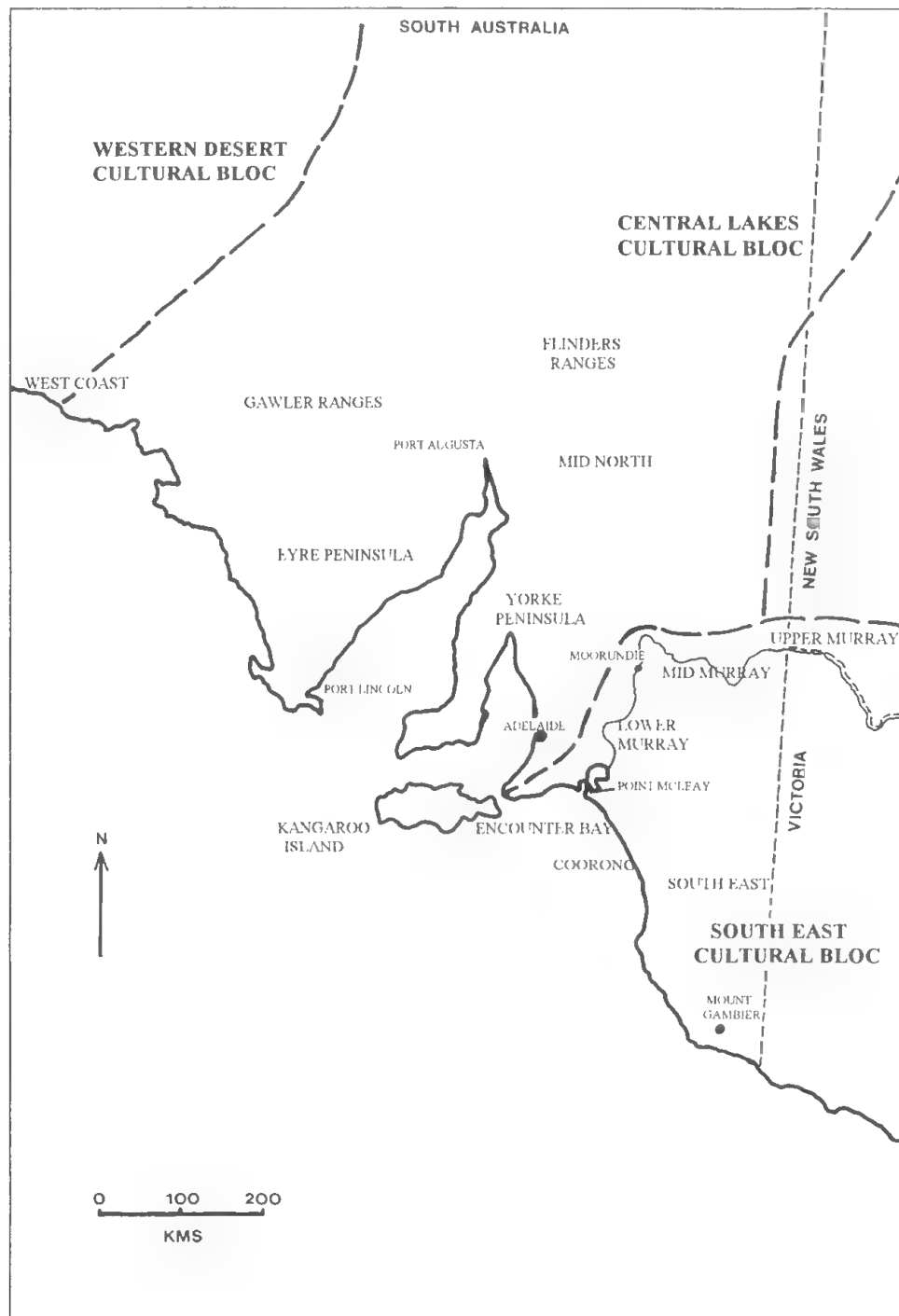


FIGURE 1. Aboriginal cultural blocs in southern South Australia.

detailed analysis of the chief historical sources used in this paper is given elsewhere (Clarke 1994: 63–81, 417–425; Clarke 1995: 145, 146). The present article is part of a larger study of Aboriginal relationships with the landscape of southern South Australia (Clarke 1990; 1991a; 1991b; 1994; 1995), which combine historical and ethnographic sources with data gathered from contemporary fieldwork. The language and cultural groups identified in the literature are mapped by Schmidt (1919) and Tindale (1940; 1974). The geographical and broad cultural regions used in this paper are identified in Figure 1.

European accounts of Aboriginal relationships to space have tended to describe territoriality over two-dimensional space, rendered as 'tribes' on maps (for example Tindale 1940, 1974). Nevertheless, from ethnographies across Australia, it is clear that Aboriginal people considered that there were other realms within the perceived cultural landscape in addition to their own terrestrial regions, to which they could travel in spirit form.⁵ Such regions are the Skyworld and the Underworld. The latter is also sometimes recorded as the 'Land to the West'.⁶ It appears that with the fragmentation of the spirit after death, both regions could be the abode of the spirit to the same Aboriginal group.⁷ These landscape perceptions are also common concepts throughout the Oceanic region (Luquet 1968: 451, 452). Such *places* are defined as psychic landscapes in this paper because they are not tangible according to a contemporary Western definition of landscape, which is concerned with topographical features. They are nevertheless important inclusions to the mapping of the total cultural landscape of the Aboriginal people.

The perceived existence of the Heavens as an analogue of the terrestrial landscape is common across Australia. This Skyworld was considered to be a region which, to some extent, obeyed the same laws as those of terrestrial regions.⁸ Teichelmann stated that the Adelaide Aboriginal people:

consider the firmament [Heavens] with its bodies as a land similar to what they are living upon... It is their opinion that all the celestial bodies were formerly living upon earth, partly as animals, partly as men, and that they left this lower region to exchange for the higher one. Therefore all the names which apply to the beings on earth they apply to the celestial bodies, and believe themselves to be obnoxious to their influence, and ascribe to them mal-formation of the body, and other accidents (Teichelmann 1841: 8).⁹

In the Adelaide area, the 'sky' was recorded as 'Ngaiera' (Teichelmann & Schurmann 1840, pt 2: 29).¹⁰ In the Parnkalla language of eastern Eyre Peninsula, it was similarly termed 'Naieri' (Schurmann 1844, vol.2: 37).¹¹

Accounts that illustrate the connectedness between the Skyworld and the terrestrial landscape exist for other parts of southern South Australia. In the Mid Murray area, Eyre noted:

One old native informed me, that all blacks, when dead, go up to the clouds, where they have plenty to eat and drink; fish, birds, and game of all kinds, with weapons and implements to take them. He then told me, that occasionally individuals had been up to the clouds, and had come back, but that such instances were very rare; his own mother, he said, had been one of the favoured few. Some one from above had let down a rope, and hauled her up by it; she remained one night, and on her return, gave a description of what she had seen in a chant, or song, which she sung for me, but of the meaning of which I could make out nothing (Eyre 1845, vol.2: 367).

It is possible that beliefs such as these reflect some influence from Christianity, perhaps gained from missionaries whom Murray River people met when receiving rations at the Native Location in Adelaide or through the education of their children at the Native School.¹² In the Lower Murray area, Taplin recorded 'Talkothere says that a little while ago he dreamed that he was sick and a line came down from heaven and fastened on his foot to pull him up there and he took out his knife and cut it and so escaped (Journals 22 April 1863)'. The connection between the spirit and the Skyworld is broad, involving both ends of an individual's life cycle. For instance, Pinkie Mack, a Yaraldi woman of the Lower Murray, claimed that before birth 'children are said to be little, flying about in the air, dropped out of a bag and they could be caught' (Harvey 1939). Presumably, the sky was perceived as being spatially very close to people living in the terrestrial region. The body of knowledge about the cosmos was not divorced from everyday living.

The Skyworld was perceived as a place where greater knowledge could be attained (Elkin 1977: 53, 75, 76, 81, 87, 90). For example, in the Adelaide area, initiates were ritually taken to the celestial region in order to gain sacred knowledge (Teichelmann & Schurmann 1840, vol.2: 13, 22). In the above quotation from Eyre, an Aboriginal woman reportedly learned a new song during a visit to the Skyworld. Similarly, in the Lower South East of South Australia, a healer reportedly gained knowledge through crossing into the

Heavens by climbing a tree (Smith 1880: 30). In south-western Victoria, Aboriginal 'doctors' and 'sorcerers' frequently claimed to have visited the Skyworld (Dawson 1881: 57,58). The perceived existence of this psychic landscape therefore had a significant role in the cultural organisation of people and space.

The Heavens were known to Lower Murray people as Waiirri.¹³ The Lower Murray people believed that they would all go to Waiirri after death (Taplin 1874 [1879: 18,19]). The Ramindjeri people had a term, 'Ngranggerakkauwull-urmi', which reportedly meant the 'arch of the heavens' (Meyer 1843: 88). The Booandik people from the Lower South East possessed the phrase 'kan-murn-a-moorn-o-noong', which apparently translated as 'up in the clouds' (Smith 1880: 134). They also called the clouds, 'moorn', which was apparently the same term for skin (Smith 1880: 129). In Gundidjmarra region of south-western Victoria, the 'smaller stars' together formed 'star earth' (Dawson 1881: 99). In Central Australia, 'tribal' or linguistic boundaries are reflected in the cosmic landscape (Maegraith 1932: 20,26). The Aboriginal ethnography of southern South Australia demonstrates the widespread perception that the sky was a landscape, similar to that of the terrestrial plane.

It appears that the sky was considered to begin at the height of a tree or at most a hill. One ethnographer claimed that the 'Lower Murray tribe do not climb trees'.¹⁴ This may possibly have been through a general fear of entering the Skyworld. If so, then presumably this only applied to upper sections of the tree, as Aboriginal people in better wooded areas still climbed trees to catch possums, collect honey, and cut bark for canoes. In the Lower Murray region, particular large trees and big sand dunes that were considered to reach the clouds and which attracted lightning strikes, were regarded as malevolent (J. C. Harwood, cited Tindale 1930-52: 193,194).¹⁵ In the Waiyungari myth of the Lower Murray, the Skyworld was reached by the throw of a spear (Tindale 1935). In the Adelaide area, a Monana spirit used a similar method to attain access to the Skyworld.

[He] was one day throwing large spears in various directions, east, west, north, south; when, having thrown one upwards, it did not return to earth. He threw another, and another, and so continued throwing; each spear sticking fast to the former one until they reached the ground, and he climbed up by them to the sky, where he has ever since remained (Wyatt 1879: 166).¹⁶

Monana was considered to be a mortal who had accomplished immortality. In the southern Eyre Peninsula district, Aboriginal people believed that thunder was caused by the spirit creator, Pulyallana, having fits of rage and storming about the clouds (Schurmann 1846 [1987: 243]; Wilhelmi 1860).¹⁷ Lightning was reportedly produced when he jerked open his legs. The Skyworld was perceived by Aboriginal people of southern South Australia as a part of the landscape that was not beyond their physical reach.

The amount of cosmological knowledge possessed by the Aboriginal people of southern South Australia must have been considerable. Teichelmann recorded that with 'the exaltation of almost every constellation they give the history of the attending circumstances, which the reasons of their present movements explain' (Teichelmann 1841: 9). The cosmos is important in the mythology associated with the ancestral creative period, called in Aboriginal English the 'Dreamtime'.¹⁸ However, there appears to have been many layers to this body of knowledge. Teichelmann wrote:

The opinions which the Aborigines of South Australia entertain about the visible world are limitedly known, as they carefully conceal them from Europeans, and even their own males are only at a certain age initiated into the knowledge of them (Teichelmann 1841: 8).

Indeed, the informants of Schurmann guarded their secrets so much that he was only told about the cosmology under the condition that he would not tell another Aboriginal person.¹⁹ The cosmic bodies were rich with meaning. This is illustrated in an account by Giles, recorded from an Aboriginal man named Billy Poole from the Lake Albert area of the Lower Murray.

When around the camp fire at night he [Billy Poole] told me the names of stars, and, moreover, of constellations. He pointed out one group as an old man kangaroo with his arm broken; another group was a turkey sitting on her eggs, the eggs being our constellation Pleiades, another a Toolicher, a small and very prettily marked kangaroo peculiar to the district; another an emu and so on.²⁰

Another record for the Lower Murray lists celestial bodies such as Nunganari (stingray), Pindjali (emu), and Prolggi (brolga) (Berndt & Berndt 1993: 164, Fig.25).²¹ The cosmic landscape was therefore, to these Aboriginal people, populated with animal species that also occurred in their terrestrial landscape of the Murray River.

Aboriginal kinship patterns were also reflected in the sky (Fig.2,3). For instance, Lower Murray people formerly believed that some of the stars were deceased ancestors, such as Ngurunderi, Waiyungari, Nepeli, Manchingga, and their families, who were now living in Waiirri.²² This is consistent with the relatively short lineages recalled by them, with their totemic ancestors ending up as stars. Meyer (1846 [1879: 201]) recorded the Ramindjeri belief that 'The stars were formerly men, and leave their huts in the evening, to go through the same employments which they did while on earth'. In the Adelaide region, Monaincherloo (= Munaintyerlo or Monaincherloo) was described as the 'highest creature'.²³ He created all things in the visible world. No one made or created him. According to one account he had always been in the Heavens above, although others state that he did live on the lower landscape once.²⁴ Another ancestral being significant to Adelaide people was Teendo Yerle, literally 'Sun-father' (= Tindoyerli & Tindojerlimejo [lit. 'Sun-father man']).²⁵ The name of Teendo Yerle suggests a father relationship with the Sun. Teendo Yerle had several wives, probably planets, who were perceived as very good. However, he also had a pair of sisters who were said to be 'long', probably comets, and evil. He had power over life and death. The Skyworld landscape was therefore humanised, to a similar extent to the lower landscape.

The influence of the stars was not always considered benign. For example, Eyre (1845, vol.2: 361) stated that Aboriginal people in the Mid Murray area considered 'Malformations of the body are attributed to the influence of the stars ... in consequence of forbidden food being eaten.' Teichelmann (1841: 9) recorded a similar belief from the Adelaide people. Similarly, the Lower Murray people believed that a being named Karungpe, who lived in Waiirri, would come down to the campfires at night, scattering the embers and causing death (Taplin Journals 27 June 1861). Southern Aboriginal people generally considered that the beings who had become stars still had some influence over earthly events.

Knowledge of the cosmos appears to have existed in the same varied manner of other bodies of mythological-based beliefs (see Clarke 1991a; Clarke 1995). In south-western Victoria, Dawson (1881: 98,99) stated:

Although the knowledge of the heavenly bodies possessed by the natives may not entitle it to be dignified by the name of astronomical science, it

greatly exceeds that of most white people. Of such importance is a knowledge of the stars to the aborigines in their night journeys, and of their positions denoting the particular seasons of the year, that astronomy is considered one of their principal branches of education. Among the tribes between the rivers Leigh and Glenelg, it is taught by men selected for their intelligence and information.

With the identification of 'Dreaming' ancestors in the Skyworld, it is clear that the cosmic bodies were referable as markers of 'Dreamtime' events in the same manner as terrestrial topographic features of the landscape. It follows that like the accounts of the 'Dreaming', we should expect the associated mythology to vary in detail even within a cultural area, although the basic structure remained the same.

Across Australia, many Aboriginal groups considered the Heavens or Skyworld to be where their spirit, or a part of it, travelled to after death (Elkin 1977; Berndt & Berndt 1993 [1981]). The accounts from the Lower Murray of the Sun and the Moon, mention that after setting they passed through the 'dwelling-places of the dead'. Taplin (Journals 12 April 1862) records that Aboriginal people in the Lower Murray had a belief that the spirits of the dead descended into the ocean at a place beyond Kangaroo Island. Nevertheless, the Skyworld was also a destination for the souls of dead people. It is therefore likely that the early Lower Murray people believed in the fragmentation of the soul in the afterlife, which conforms to the beliefs of other southern Aboriginal groups.²⁶ The movements of the Dreaming ancestors in the Lower Murray also shows this division. For instance, Ngurunderi was perceived as going to live in the west after creating the Lower Murray (Clarke 1995). The west here was equated with the Underworld, where the Sun passed through after setting in the western horizon. However, Ngurunderi was also thought to be present in the Skyworld. From here he directed the movement of souls, termed 'pangari' by Lower Murray people (Meyer 1843: 90; Taplin 1879: 138). Angas (1847: 97) records that 'after death the spirit wanders in the dark for some time, until it finds a string when ... Oorundoo [Ngurunderi] pulls it up from the earth.' It is possible that the introduction of Christianity influenced south-eastern Australian Aboriginal beliefs about spirit ancestors who went up into the Sky.²⁷ Other Dreaming ancestors became divided in a different way. For instance, in the southern Fleurieu Peninsula area, the body of the Tjirbruki ancestral creator became a stone, and his spirit

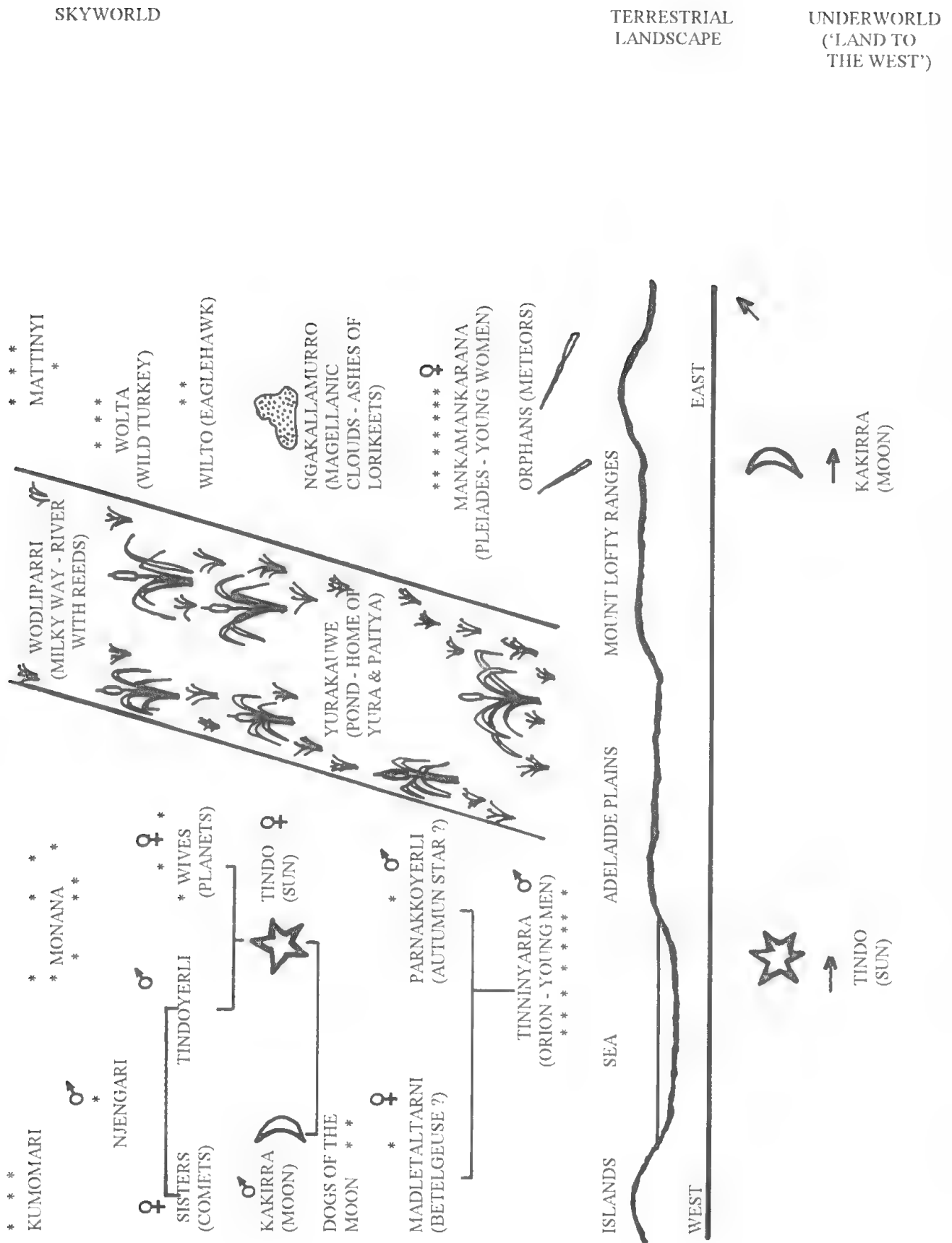


FIGURE 2. The Aboriginal cosmic landscape of the Adelaide area.

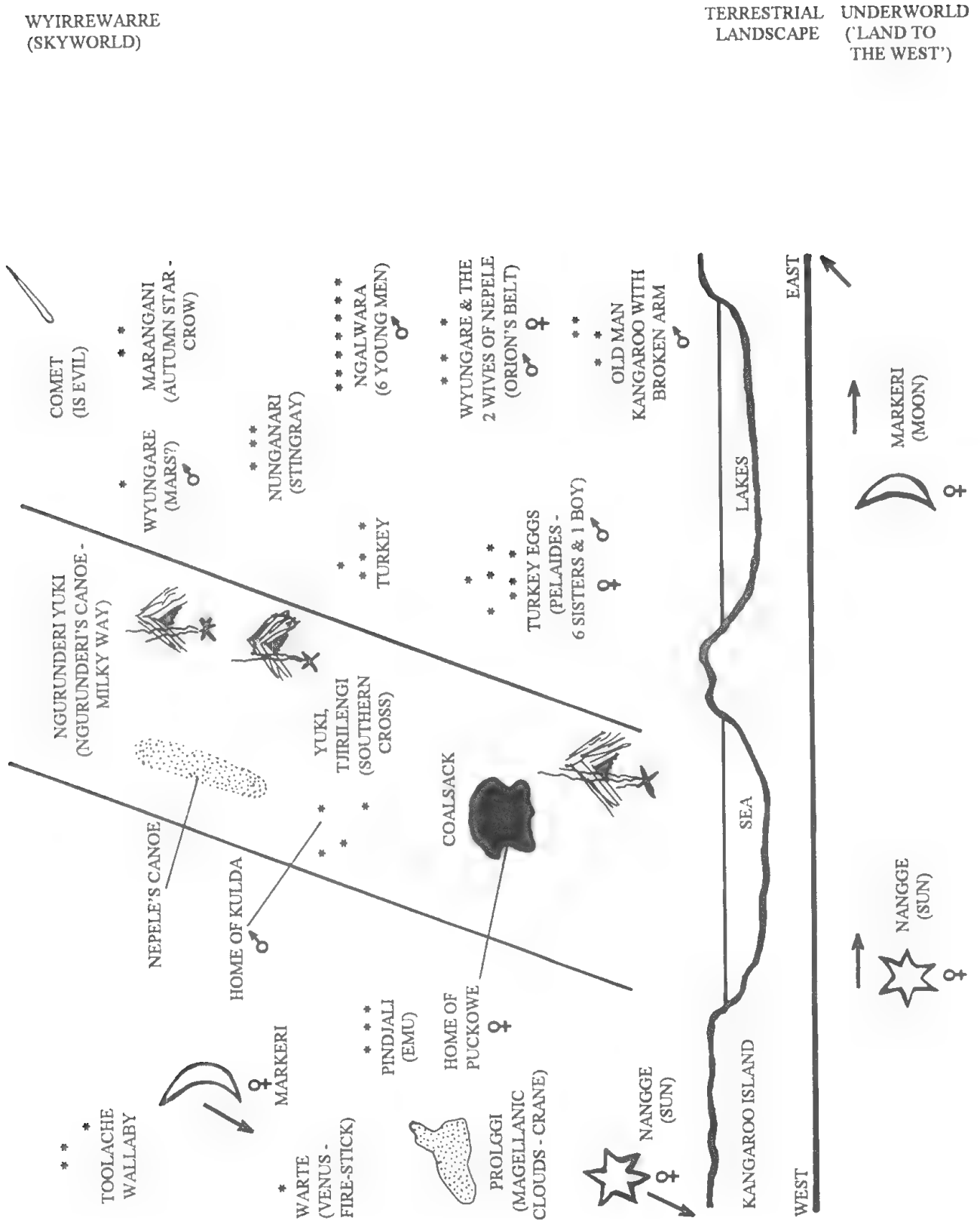


FIGURE 3. The Aboriginal cosmic landscape of the Lower Murray.

was transformed into a blue crane (Smith 1930: 340,341).²⁸ With Aboriginal beliefs in the spirit, it is clear that the total landscape defined both the living and the dead.

Although the original traditions were rich, the cultural information garnered from the historical literature is fragmentary and sometimes contradictory. At least some of the variations in beliefs about the cosmos may have resulted from the differences between insider and outsider knowledge. In other cases, the differences may reflect regional and socio-political influences. A few of the records also indicate an error by the recorder. In some cases, the combinations of stars which form a constellation for Europeans, differ from those that other cultural groups have chosen. Therefore, the translator may not be accurately recording the identity of some of the constellations as perceived by Aboriginal people. Elsewhere in Aboriginal Australia, colour was important in determining the identity of various celestial bodies (Maegraith 1932: 25). With these restraints in mind, an outline will now be provided of the Aboriginal cosmology of southern South Australia.

STARS (GENERALLY)

In the Adelaide area, stars as a class were called 'purli'.²⁹ Similar terms for other areas include 'purdli' or 'purli' in the Parnkalla language of eastern Eyre Peninsula (Schurmann 1844, vol.2: 61), 'buli' in Narangga from Yorke Peninsula (Black 1920: 86), 'purtli' or 'purlali' in Nukunu of the southern Flinders Ranges (Hercus 1992: 27), 'budli' in Ngadjuri of the Mid North of South Australia, 'buudli' in Wailpi of the central Flinders Ranges (Berndt & Vogelsang 1941: 9), and 'pedli' in the Ngaiawang language of the Mid Murray area (Moorhouse 1843 [1935: 34]).³⁰ In the Lower Murray area, stars were collectively called 'tulde' by Ramindjeri people at Encounter Bay (Meyer 1843: 101), 'tuldar' in the Ngarrindjeri language of the Lower Lakes area (Taplin 1879: 138), and 'thildi' in the southern Coorong district (Wells 1852-1855: 112). In the South East, the star terms are 'troot' in the Tatiara language (Haynes & Curr, in Curr 1886, vol.3: 457,459), and 'boongil' in Booandik from Mount Gambier (Stewart, in Curr 1886, vol.3: 465).

MOON

In Adelaide mythology, the first celestial body

to leave the lower landscape was the Moon. Here, the Moon, known as Kakirra, was considered to be male.³¹ He persuaded all the rest to follow so that he might have companions. The Moon kept a great number of dogs for hunting, who were seen as stars. They had two heads but no tail. He was generally benevolent and had no particular influence on human life. Here, the Moon was called Kakirramunto when in full phase. In Nukunu mythology from the southern Flinders Ranges, there was a related account of how the Moon entered the Skyworld:

The Moon [Pira] was greedy with meat and would not share it with others, crowd decided to get rid of him, coaxed him to climb a tree and get grubs, coaxed him up higher and higher until they could hardly see him. They cut the tree down, and the Moon hung up in the sky. Moon said 'I'll give the light for people who walk at night. I'll die then come to life again (Mountford, cited Hercus 1992: 16,17).

In the Mid Murray region, Aboriginal people used the term, 'Kakere', or variations of it for the Moon.³² One group of people was known to Murray River as the 'Moon men' (Tindale 1953: 17,31,32). Their territory, north of Morgan, was the 'country of the Moon'. A 'tribe' to the east of the Adelaide region apparently called the Moon, Piki, although this term also appeared in an example of a sentence spoken by an Adelaide person (Teichelmann & Schurmann 1840, vol.2: 38; Teichelmann, 1857). Near the confluence of the Darling and Murray Rivers, the Maraura called the Moon, 'Patjira' (Tindale 1930-52: 251). In the Eyre Peninsula and West Coast districts the Moon was considered to be the spirit being, Piira, who was once a man who chased the Seven Sisters (Pleiades) across the landscape (Tindale 1928: 21).³³

To the Lower Murray people, the Moon was called Markeri, or variations of it.³⁴ In contrast to the Adelaide area, here the Moon was female. Meyer stated that the Ramindjeri people believed that, like the Sun, the Moon spends its time away from the sight of the terrestrial landscape with men of the 'dwelling-places of the dead' (= Underworld). He recorded:

The Moon is ... a woman, and not particularly chaste. She stays a long time with the men, and from the effects of her intercourse with them, she becomes very thin, and wastes away to a mere skeleton. When in this state, Nurrunduri [Ngurunderi] orders her to be driven away. She flies, and is secreted for sometime, but is employed all the time in seeking roots which are so nourishing that in a short time she appears again, and fills out and becomes fat rapidly (Meyer 1846 [1879: 200,201]).

This belief explains how the Moon's appearance is not timed to the Sun, and also accounts for the phases of the lunar month.³⁵ The Yaraldi people of Lake Alexandrina had similar traditions to the Ramindjeri concerning the Moon (Berndt & Berndt 1993: 131,232,233,445). They also believed that the lunar cycle had an effect upon female menstruation (Berndt & Berndt 1993: 156). Further up the Murray River, into northern Victoria, the Moon was considered to be female, as it was in the Lower Murray (Smyth 1878, vol.1: 431).

The Potaruwutj people of Keilira in the South East called the Moon, Mitjan, and considered it to be a male of the native cat (*Dasyurus*) totem.³⁶ It was believed that he attempted to steal the wife of another being before being driven away. He wandered about, sometimes well fed, at other times starving. This observation explains the phases of the Moon. According to Tindale, the name, Mitjan, or a variation of it, was used by groups ranging to the north-east, as far away as the Wati Wati people of Swan Hill in Victoria.³⁷ The term, Jern (pronounced Yern?) for Moon occurred in groups to the east of the Potaruwutj. Similarly, Tu:ngum was used in the Lower South East of South Australia and in the adjacent parts of Victoria.³⁸ Here, the Moon was also considered to be masculine (Dawson 1881: 99).

In southern South Australia, the appearance of the Moon was used as a measure of time. In the southern Coorong district, the number of full Moons was sometimes used to record the age of children, if less than a year old (Wells 1852–1855: 102). Similarly, in the Hahndorf area of the Adelaide Hills, the local Aboriginal people were observed making notches in their digging-sticks upon the appearance of each new Moon to mark their own age (Hahn 1838–1839 [1964: 130,131]). However, it is doubtful that this served as a long term counting device. Some activities were governed by the phases of the Moon. For instance, a colonist noted that 'at every new Moon they [Aboriginal people] also light fires in the hills. From this fact, people conclude that they adore and worship the Moon' (Hahn 1838–1839 [1964: 133]). Moonlight was regarded as a deterrent for harmful spirits, who were chiefly active during the darkness of night.³⁹ The Ramindjeri called a half Moon, 'Marger-ald-narte', meaning 'Moon of piece', whereas a full Moon was 'Marger-ald rakkuni', that is 'Moon of round' (Meyer 1843: 78). In the southern Coorong area, 'Mercuri' (= Markeri) reportedly meant both the Moon and the night (Wells 1852–1855: 112).

In the Lower South East, the Booandik term for the Moon, Toongoom, was reportedly also used to indicate a period of a month (Smith 1880: 131).

SUN

In the Adelaide area, the Sun, known as Tindu, was said to be female and, with her several sisters, had a negative influence over humans.⁴⁰ One of the afflictions perceived as caused by the Sun was a very painful and often fatal cough. The Moon taught the Adelaide people that should a very ill person offer a hand of coughed up phlegm to the Sun as a form of appeasement, that person might recover (Wyatt 1879: 166,167). However, if not properly appeased, the Sun said 'Noornte oornte, wirilla pallone ningko' which means 'Go away, quickly dead you'. The Sun also had a negative effect on the Moon who was old and suffered from a strong cough. She was able to easily beat him every month so that he died. But in dying he revived again. Of the Sun and the Moon it was said 'Tikkan teendo, wandeen olte, karkara tatteen, boora pallon'.⁴¹ This reportedly meant that the Sun rested or slept at night while the Moon climbed and eventually died. By another account the Sun sat in her house at night and ate fish.⁴² It is likely that the observable difference in the relative strength of illumination between the Sun and the Moon is a factor in this perceived Aboriginal dichotomy of strength versus weakness. The term, 'Tindu', or variations of it, appears in several languages to the north and west of the Adelaide area.⁴³ In Ngadjuri mythology of the Mid North of South Australia, the Sun went to the Underworld (= Land of the West) for the first time as the result of the killing of an old woman and her two dogs (Tindale 1937). Tindale's explanation for this myth is that it is an Aboriginal record of a complete lunar eclipse that occurred in 1793.

The Ramindjeri people of Encounter Bay believed that the Sun was female. Meyer recorded:

The Sun they consider to be female, who, when she sets, passes the dwelling-places of the dead. As she approaches, the men assemble, and divide into two bodies, leaving a road for her to pass between them: they invite her to stay with them, which she can only do for a short time, as she must be ready for her journey for the next day. For favours granted to some one among them she receives a present of a red kangaroo skin; and, therefore, in the morning, when she rises, appears in a red dress (Meyer 1846 [1879: 200]).

Their name for Sun was 'Thulderni'.⁴⁴ For the Yaraldi of the Lower Lakes, there was a similar tradition recorded (Berndt & Berndt 1993: 232,233,444). The Sun's heat, 'watali', was the nga:tji (spirit familiar) of the Wutaltinyeri descent group north of Meningie on the shore of Lake Albert in the Lower Murray, whereas the Sun's disc, 'nangge', was that of another unnamed group (Berndt & Berndt 1993: 215). In the Lower Murray area, Aboriginal people generally called the Sun, 'Nangge' (Meyer 1843: 84; Taplin 1874 [1879: 131]; Taplin 1879: 139,142).⁴⁵ In the Mid Murray area, the term for sun was 'Nanka', or variations of it.⁴⁶ Here, a local landowning group was known as the 'Sun people' (Tindale 1953: 7).⁴⁷

There was a belief amongst the Tangani of the Coorong that the Sun was in earlier times much brighter. Tindale records:

Wange [sic.? = Nangge?] was a Sun woman, a being who, in ancient times, climbed into the heavens where she carried firesticks; but these firesticks did little for people on earth in keeping them from being cold. The light from her firesticks was too bright. Another being still on earth, named Nure:le, magically forced her to be less vigorous in waving her firesticks, instead of affording much bright light there was a greater amount of red glow. Thus people could remain warm (Tindale 1983: 7).

This belief relates to the observation by Aboriginal people that for maximum heat their own campfires needed more red coals, and less bright flame. In their society it was the older women who had responsibility for maintaining the fires. During the initiations in the South East of South Australia, the female gender of the Sun Being was reportedly an embarrassment to the Aboriginal people (Tindale 1983: 9). Her role in the ceremony was represented temporarily by 'her brother', who carried paired firesticks which were symbolic of those that lit up the earth from above. However, it is unclear whether this was a pre-European practice, or one resulting from more contact between Aboriginal groups after European colonisation.

The Tangani people of the Coorong called the day, 'nangi', and the Sun itself was 'Tulduruwi' or 'Taldarawei'.⁴⁸ In the southern Coorong region, the recorded name for Sun was 'Thildiroor', with a related term, 'thildirooi', which was said to mean a 'day' (Wells 1852-1855: 112). A nearby inland group, the Potaruwutj people, apparently called a day, 'kado', and the Sun, 'Kardu', and Sunrise, 'Tarkinj'.⁴⁹ In the Lower South East, the

Booandik term for both the Sun and a day was reportedly 'Karo', the rising Sun, 'Yoong-in-karo', and the Sun having set was 'Kap-an-a-karo' (Smith 1880: 129,132,134).⁵⁰ In the South East of South Australia, and the adjacent area of south-western Victoria, the Sun appears generally to have been considered a female entity (Dawson 1881: 99).

MILKY WAY

The Aboriginal cosmic landscape was dominated by the Milky Way. It was considered by the Adelaide people to be a large river, along the banks of which reeds were growing (Teichelmann & Schurmann 1840, vol.2: 11,35,38,57,62; Teichelmann 1841: 8). The Milky Way was given the name 'Wodliparri', which literally means 'hut-river'. The Ngadjuri people of the Mid North of South Australia had a similar term for the Milky Way, 'Walibari' (Berndt & Vogelsang 1941: 7), as did the Nukunu people in the southern Flinders Ranges, who called it 'Waarli Pari' (Hercus 1992: 29). Similarly, the Gundidjmara in south-western Victoria reportedly considered this large cosmic feature to be a 'big river' (Dawson 1881: 99). The habitations of the deceased as a group were an important element of the Milky Way. A nineteenth century observer claimed that:

In parts of Queensland and South Australia the natives believed the "Milky Way" to be a sort of celestial place for disembodied spirits. They said it was the smoke proceeding from celestial grass which had been set on fire by their departed women, the signal being intended to guide the ghosts of the deceased to the eternal camp fires of the tribe.⁵¹

Similarly, to the Ngaiawang of the Mid Murray, the Milky Way was symbolic of the Murray River, with the stars being men hunting game in the mallee on either side.⁵² For the Nukunu, another important association with the Milky Way was that it represented a huge tree, like a ceremonial pole (Hercus 1992: 13-16). In this context, it was part of the Urumbula song-line which runs from the vicinity of Port Augusta all the way to the Gulf of Carpentaria.⁵³ The Milky Way was therefore widely considered an important topographical feature of the cosmic landscape.

The Adelaide people considered that the dark spots in the Milky Way were water lagoons in which a 'magnificent animal' or 'monster' called Yura lived. One record actually describes Yura as

a group of monsters, although other accounts mention Yura as a single being (Schurmann Diaries 5 June 1839; Teichelmann 1841: 8). These dark spots were known as Yurakauwe, which translates as 'monster-water'. Adelaide people claimed that the monster Yura was vicious and would swallow people who did not hide from him. When he appeared, an abundance of water was created. Yura was the 'author' of circumcision and first taught the practice to the ancestors of the Adelaide people. He punished those who neglected it. Yura lived in the sky with Paitya, another dangerous monster. Schurmann recorded that women and children were not allowed to know of these things.

Yura is analogous to the Akurra, the huge mythical water snake of the Flinders Ranges (Tunbridge 1988: 5–11), and to Akaru, the Ngadjuri equivalent (Berndt & Vogelsang 1941: 9). The Akurra was sometimes considered to be a single being, although able to be in many places at once. This characteristic may help to explain how in the Adelaide area beings like the Yura and the Monana can be conceived as existing both in the singular and plural forms. Similarities of Yura with the Australian-wide Rainbow Serpent mythology are also significant (see Radcliffe Brown 1930).

According to Meyer (1846 [1879: 202]), the Milky Way was considered by the Ramindjeri people of the extended Lower Murray area to be a row of huts, among which were heaps of ashes and ascending smoke. Another account of the Milky Way, given by George Taplin, concerns the Ngurunderi myth (1874 [1879: 57]). Taplin related that when Ngurunderi caused the drowning of his fleeing wives, a flood occurred at Point McLeay (Rauwoke). Nepeli, who was living there, was forced to pull up his canoe to the top of the cliff (now called 'Big Hill'). From here, the canoe was transported to Waiirri, and thereafter the dense part of the Milky Way was said to be the canoe of Nepeli floating in the Heavens. According to Berndt's informant, Karloan, Ngurunderi made the Milky Way while at Mount Misery by placing his canoe in the sky (Berndt 1940: 173; Berndt & Berndt 1993: 224). He explained that the Milky Way was called 'Ngurunderi yuki', said to mean 'Ngurunderi's canoe'. Both Nepeli and Waiyungari were considered to live in the Milky Way (Smith 1930: 183). A version recorded by Harvey (1939) from Aboriginal informants, Jacob Harris and Creighton Unaipon, suggests that Nepeli threw his spear into the sky and this became the Milky Way.

MAGELLANIC CLOUDS

The Adelaide people called the Magellanic clouds, 'Ngakallamurro', said to literally mean 'paroquet-ashes' (Teichelmann & Schurmann 1840, vol.2: 25,30; Teichelmann 1841: 8). Being white, they represent the ashes of a species of 'paroquet' known as the Blue Mountain lorikeet (*Trichoglossus haematodus*). These birds were assembled there by one of the constellations and were later treacherously roasted.

The Magellanic Clouds were known in the Lower Murray as Prolggi, which was translated as 'cranes' (Taplin 1879: 133). In Australian English we know them as brolgas or native companions.⁵⁴ The Yaraldi considered that there were two Prolggi in the sky, having got there after fighting with the emu spirit, Pindjali, who also became a heavenly body (Tindale 1931–34: 207–209; 1938–56: 33–61; Berndt & Berndt 1993:15,164,456–458).⁵⁵ Tindale recorded the following account from Mark Wilson, a Yaraldi man:

The brolgas, knowing that the emus would hunt them and kill them, flew up into the air, circling around, higher and higher, until they reached the sky. They found it to be a good country to live in, so they stopped there. You can see them in the heavens at night, "in the form of two patches of clouds, like wisps of smoke, at the end of the Milky Way." The aborigines' belief is that when any one of them is knocked down and left bruised and unconscious on the ground by a person from another tribe, the brolgas come down, lift him up and guide him home (Tindale 1931–34: 207–9).

To the Lower Murray people then, the brolgas in the Skyworld exerted a benign influence. A similar account was provided to Tindale (1934–37: 60) from a Meintangk informant who claimed that the emu concerned was to be seen in the sky just under the Southern Cross. The fight in the myth was apparently due to the jealousy of the emu over the brolga's children. This mythology appears to be related to Gundidjmarra beliefs, which held that the larger cloud was the 'male native companion' or 'gigantic crane', the smaller cloud being the female equivalent (Dawson 1881: 99). A similar version has also been recorded in the Kamilaroi language of northern central New South Wales (Austin & Tindale 1985). As with their terrestrial counterparts, these celestial spirit beings migrated according to the season. In the winter sky, the brolgas are seen lying to the south-east and then south of the Milky Way (Tindale 1938–56: 57). In summer they shift towards the western side.

PLEIADES

The Adelaide people considered the higher landscape to be similarly organised to the lower, to the extent that the celestial bodies were believed to obey the same laws as men and animals upon earth. For example, the Pleiades, which were called 'Mankamankarranna' (also Mankankarrana and Mangkamangkarranna), were considered to be girls who gathered roots and other vegetables around them in the sky.⁵⁶ The Narangga people of Yorke Peninsula had a similar mythology. They called the Pleiades the 'Mangga Manggaridi', who were said to be 'maids' (Black 1920: 87). In the Parnkalla language of eastern Eyre Peninsula, the Pleiades were recorded as women, called 'Pallarri' (Schurmann 1844, vol.2: 51). Similarly, in Nukunu mythology, the seven sisters or 'Purlara', were reportedly chased into the sky by three brothers (Hercus 1992: 7,16,27). One sister became sick and stayed on the terrestrial landscape. These are clearly related accounts to the Seven Sisters Dreaming of the Western Desert, where the young women, called Kungkarungkara, are chased by Orion (Tindale 1959). Here they appear in the dawn sky during April/May, being the start of a ceremonial cycle.⁵⁷ The southern myths also bear resemblance to the Mankarawora (Pleiades) of the Diyari in the north-east of South Australia (Berndt & Vogelsang 1941: 8). In the cosmology of the Adnyamathanha people of the Flinders Ranges, the Pleiades were known as the Makara or Artunyi, meaning a group of women (Mountford 1939: 103,104; 1976: 33–35; Mountford & Roberts 1970: 56; Tunbridge 1988: 16). They believed that the Akurra serpent ancestor ate the Artunyi women at Yandara in New South Wales, and that these women were later released into the sky when he drowned. Most beliefs concerning the Pleiades simply record a number of sisters, because Aboriginal counting systems before European contact had little use for figures greater than three.

In the account of cosmology recorded from Billy Poole of the Lake Albert area, the Pleiades represented the eggs that another constellation, a Turkey, was sitting upon.⁵⁸ For the southern Coorong district, 'the Seven Stars are black men sitting round a fire, of course they are smoking (Wells 1852–1855: 99)'. In south-western Victoria there are various accounts of the Pleiades, representing a flock of female cockatoos, or six women whose 'Queen' had been taken by the crow, signified by Canopus (Dawson 1881: 100). The Pleiades are probably the Yatuka

constellation that Yaraldi people believed comprised six girls and one boy (Berndt & Berndt 1993: 163,164). This may relate to the Tangani belief that the Pleiades, called by them Mantjingga, were seven or eight girls and a single boy.⁵⁹ He went with them because his fire had gone out. Munaijeri was one of the Mantjingga who went away (Tindale 1930–52: 290). The Pleiades are known in many cultures of the world as the Seven Sisters.⁶⁰

ORION

In the Adelaide region, the stars of the Orion constellation were called Tinniinyarra (also Tinniinyaranna and Kurkukurkurra). They were considered to be youths who hunted kangaroos, emus and other game on the great celestial plain, called the Womma.⁶¹ The mother of the Tinniinyarra was a red star called Madletaltarni (Teichelmann & Schurmann 1840, vol.2: 17,37,42). This is probably the star astronomers call Betelgeuse. The father of the Tinniinyarra was a star called Parnakkoyerli. To the Parnkalla people of eastern Eyre Peninsula, the Orion constellation could be termed either Minye or Mirrarri, considered to be men or boys (Schurmann 1884, vol.2: 33). In the Western Desert mythology, Orion, called Njiru, chased the Pleiades across the terrestrial landscape, as he still does in the Skyworld (Tindale 1959).

A version of the Waiyungari story recorded in the Lower Murray region from an early Narrung resident has Waiyungari and the two escaping wives of Nepeli, who are sisters, becoming the three great stars of Orion's belt.⁶² As reported below, Tindale's version has Waiyungari becoming the planet Mars. In relation to Orion's belt, there is a close parallel in the beliefs of the Gundidjmarra people of south-western Victoria where three stars were the sisters of Sirius who always followed him (Dawson 1881: 100). There also, a red star in the constellation of Orion was called 'fire', and was masculine. The Ngalwara constellation recorded in Yaraldi cosmology, which was perceived as six young men (Berndt & Berndt 1993: 164), is possibly Orion. The Tangani called the seven boys the Ngawiri.⁶³

THE SOUTHERN CROSS AND THE COAL SACK

In the Ngadjuri language of the Mid North of South Australia, the Southern Cross was called

'Wildu', the eagle (Berndt & Vogelsang 1941: 9). To the Parnkalla people of eastern Eyre Peninsula, the Southern Cross and adjacent stars were termed 'Kadnakadna purdli' (Schurmann 1844, vol.2: 9). The Tangani people of the Coorong had a death fear song concerning the arrival of a smallpox epidemic (Tindale 1937: 111,112; Tindale 1941: 233,234).⁶⁴ As part of the story of this song, a 'dream man', Kulda, came down to the lower landscape from the Southern Cross, called Yu:ki.⁶⁵ He foretold the coming of death, with his 'pointing bone' taking the spirits of the dead with him to Kangaroo Island. Tindale recorded that:

The natives saw a man (meteor) come out of Yuuki, the Southern Cross; they heard a noise and looked up (meinyanga nampi). They saw him move his hands and said 'Ha! peika bakki' ('Ah! death coming'; 'peik' = 'die'). The natives could not stand the murki [smallpox] and a great many died. The meteor was a maldawuli man whose name was Kuldalai, he travelled westward through the sky and beckoned to indicate that all the people should follow him. Then the smallpox came and many people followed him (literally went west) across to Kangaroo Island and beyond (Tindale 1931-34: 232).

Furthermore, Tindale (1931-34: 251,252) recorded that Kulda appeared 'like a bright flash, too bright to look.' The method he used to attract people was first by smoke signals, then by waving hands. Tindale's Aboriginal informants believed that many of the bones in the sandhills of the Lower Murray belonged to people whom Kulda had beckoned to follow him. This account is further illustration of the perceived connections between the Skyworld, Land to the West, and the terrestrial landscape.

A Meintangk informant told Tindale (1934-37: 60) that 'The black patch (Coal Sack) in the Southern Cross is the emu ... The Southern Cross stars are men.' The emu in this instance was probably the spirit who fought with the brolgas, as already noted above. According to the Europeanised mythology of Smith, the 'Grandmother Spirit', known as Puckowe, was considered by Lower Murray people to inhabit the dark spot in the Milky Way, known as the Coal Sack (Smith 1930: 184,185,199). Aboriginal healers in the Lower Murray could reportedly appeal to her for help. The Gundidjmarra people in south-western Victoria apparently believed that a 'bunyip', a mythical water spirit, lived simultaneously both in the Coal Sack and in parts of the terrestrial landscape (Dawson 1881: 99).

LYRA

The 'doctor men' of the Tangani interpreted the appearance of Vega, called by them Lawarikark, in the constellation of Lyra as indicating the nesting time of mallee fowls (Tindale 1983: 26).⁶⁶ These birds, called lawari or lowan, make a harsh scolding noise when racking the leaves for their nests. For this reason, Aboriginal people considered this constellation to have quarrelsome properties.

SEASONAL BODIES

To the Adelaide people, the arrival of Parna in early autumn indicated the change of season and was a sign that large and waterproof huts needed to be built in the Adelaide foothills (Gell 1842 [reprint 1988: 7,9]). The Aboriginal place name for a hilltop campsite at Morphett Vale, south of Adelaide, was Parnangga.⁶⁷ This reportedly meant 'autumn rains', and referred to the appearance of Parna.⁶⁸ Similarly the Ngarrindjeri called autumn, Marangani, which is a time when stars of this name appear (Taplin 1879: 126). The Yaraldi term recorded for autumn, Marangalkadi, was said to mean 'pertaining to the crow' (Berndt & Berndt 1993: 21,76,240). Marangani was a crow (more properly called a raven) in the creative period of the Yaraldi 'Dreamtime' (Meyer 1843: 78; Berndt & Berndt 1993: 163,240-242). According to Yaraldi tradition, the autumn stars are low in the south-eastern sky because it was to the south-east of the Lower Murray that the crow spirit entered the Skyworld. When Marangani was at its zenith, both animals and humans were thought to enter the 'rutting season' (Tindale 1930-52: 266). Women in particular were considered to be easily affected by Marangani, making some individuals promiscuous.

In the Adelaide area, spring was termed Willutti or Wiltutti (Teichelmann & Schurmann 1840, vol.2: 55; Teichelmann 1857). It was under the influence of the constellation of the eagle, Wilto. It is likely that Wilto was the Southern Cross, through the apparent relationship between Wiltu in the Adelaide language and Wildu of the Ngadjuri mentioned above. Similarly, in the Adelaide area summer was governed by the wild turkey constellation, Wolta (Teichelmann & Schurmann 1840, vol.2: 57,58; Teichelmann 1857). Summer was therefore called Woltatti. The linking of seasons with the movements of celestial bodies is common across Australia (Clarke 1990: 6; Clarke 1991a: 59).

UNIDENTIFIED STARS

In the ethnographies of southern South Australia, there are several names for stars where identification is difficult due to lack of description. One example is Njengari, who reportedly was once a mortal on earth (Tindale 1941: 235; Tindale 1987: 12). He had a happy nature and was often observed dancing. He created a smooth dancing spot along the coast at a place called Watbardok in the Normanville area south of Adelaide. This later became an excellent fishing spot as nets could be drawn here without snagging. Njengari was a clansman of Tjirbruki, who was also a landscape-creating ancestor. Njengari was eventually transformed into a star. There are also recorded names from the Adelaide language for constellations such as 'Mattinyi' and 'Kumomari', for which there is no European equivalent given (Teichelmann & Schurmann 1840, vol.2: 13,22). Similarly, 'Yurdlakka' was said to be 'a star or constellation' in the Parnkalla language (Schurmann 1844, vol.2: 87). The identity of these was not known to the recorder. In the Gundidjmarra region of south-western Victoria, larger stars (and probably planets) were feminine and considered to be 'sisters of the Sun' (Dawson 1881: 99).

In the Lower Murray region, there was a celestial body that appeared every few years as a good omen. Tindale reports:

Nalkari – a special star or planet which appears every four or five years. It causes the fish to die in thousands and to float along the river banks. The people are glad when they see Nalkari for it means that much food can be obtained (Tindale 1934–37: 147).

The identity of this cosmic body is unknown, although it seems unlikely to be a comet, as these were universally held in great fear.

PLANETS

In the Adelaide region, the Sun-father, Teendo Yerle, had several wives which Schurmann thought were probably planets.⁶⁹ In contrast to the sisters of Teendo Yerle who were bad, the wives were considered to be very good. In the case of the Lower Murray traditions, a version of the Waiyungari myth provided a Yaraldi account of the origin of the planet Mars (Tindale 1935). Tindale had several Aboriginal sources who confirmed that Waiyungari became Mars after he and the two wives of Nepeli fled into the sky. The

Ramindjeri people considered that Waiyungari became a 'star' (Meyer 1843: 105). Waiyungari was said to actually mean 'he who returns to the stars' (Smith 1930: 250). However, there is no ethnographic record of the celestial identity of the two women of who accompanied him. A past Government Astronomer, G. F. Dodwell, suggested that they might have been perceived as Jupiter and Venus, as both of these planets move over the Heavens, coming into conjunction with Mars (cited in Tindale 1931–34: 189; Tindale 1935: 270–274). However, another record of the Waiyungari myth stated that his home was in the Milky Way (Smith 1930: 183,251). According to this version, Aboriginal people pointed out three stars in the eastern sky which represented Waiyungari and his two wives. Other accounts of Mars, perhaps associated with the Waiyungari mythology, state that when the 'red star' is shining at its 'hottest' and 'brightest', it is blamed for increasing sexual desire (Berndt & Berndt 1951: 223; Berndt & Berndt 1993: 164). To the Gundidjmarra people of south-western Victoria, Mars was a feminine entity (Dawson 1881: 99).

According to George Taplin (1879: 135,140), Venus was termed Warte by the Ngarrindjeri. This term has also been recorded to mean 'firestick' (Meyer 1843: 106). Presumably the relative strong brightness of Venus adds to its association with fire. The Gundidjmarra apparently considered Venus to be the 'mother of the sun' (Dawson 1881: 99). This tradition is possibly linked to the notion that Venus sometimes accompanied the Sun across the Skyworld, as it is visible during the day. In the recorded Parnkalla language of eastern Eyre Peninsula, the 'evening star' (Venus) was 'Kabminye' (Schurmann 1844, vol.2: 9). At the confluence of the Murray and Darling Rivers, the 'evening star' (Venus) was reportedly called 'Pudli' or 'Pudali' (Tindale 1930–52: 255), although this may have simply meant 'a star'.

METEORS

Although many of the celestial bodies were linked to each other through kinship, in the Adelaide region meteoric lights (or shooting stars) were said to be 'orphans'.⁷⁰ Their ephemeral and unregulated nature may have contributed to this classification. Generally, meteors were considered to be bad omens, especially in times of great social disruption. The account of Kulda, perceived as a meteor who came out of the Southern Cross, is a good illustration of this. Furthermore, when a

falling star was seen, the Tangani people of the Coorong reportedly said 'peika bak:i', that is 'death coming'.⁷¹ Tindale (1938) linked the myth of Prupi, a cannibalistic woman living along the southern Coorong who was killed by fire, with a meteorite fall in the area. Furthermore, to the Gundidjmarra people of south-western Victoria, a meteor represented 'deformity' (Dawson 1881: 101). In north-western Victoria, a meteor 'portends evil to those that have lost a front tooth, to avert which they stir the fire and cast about firebrands (Stanbridge 1857: 140)'.

COMETS

The Adelaide people believed that Teendo Yerle or Sun-father, had a pair of evil sisters who were 'long' and probably comets.⁷² Aboriginal people here considered most of the unusual cosmic phenomenon they observed to be a 'sure harbinger of death [which filled] them with awe and terror' (Schurmann 1846 [1879: 242]). In March 1843, a comet visible to Aboriginal people from along the Murray River was taken as a:

harbinger of all kinds of calamities, and more especially to the white people. It was considered that the comet would overthrow Adelaide, destroying all Europeans and their houses, and then to take a course up the Murray and past the Rufus River causing havoc in its path' (Eyre 1845, vol.2: 358,359).⁷³

It was believed to have been created by northern Aboriginal people who were powerful sorcerers. On this occasion, the Resident Magistrate at Moorunde, Eyre, was told by river Aboriginal people to go to Adelaide and procure the release of an Aboriginal man from the north gaoled for assaulting a shepherd. If this was done, he was told that disaster would be averted. The disquiet caused by unusual cosmic phenomena appears to have been widespread. In the Port Lincoln area, the 1843 comet caused Aboriginal people to hide in caves (Schurmann 1846 [1879: 242]).⁷⁴ The Gundidjmarra people of south-western Victoria considered a comet to be a great spirit (Dawson 1881: 101).

OTHER CELESTIAL EVENTS

There were also other celestial events that were perceived to be bad signs. In the Adelaide area, the Southern Lights foretold disease.⁷⁵ Furthermore, an eclipse was considered to cause death and destruction. Aboriginal people at Point McLeay in the Lower Murray area were very fearful of the Aurora Australis and the eclipse of the Moon (Taplin Journals 4–7 June 1859, 2 September 1859). Both events were said to have been created by 'wild blackfellows', an early Aboriginal English term for 'uncivilised' groups living beyond the European colonial frontier. Such people were often feared as sorcerers. In the case of the Aurora Australis, it foretold the arrival of these dangerous human/spirit beings.

DISCUSSION

This paper illustrates that the connections between Skyworld, terrestrial land and the Underworld were crucial parts of Aboriginal cosmology. Perceived events and influences from the cosmic landscape had a significant role in the ordering of human life. The observable seasonal changes in the cosmos, due to the movement of planets and constellations, mimicked the terrestrial movements of people and animals. These observances would have strengthened the perception that the cosmos was a landscape. These psychic regions were considered by Aboriginal people to be part of the land that they 'used'. With a social kinship system linking many of the celestial bodies, it can be seen that the cosmos and earthly landscapes were in at least one sense reflections of each other. The total cultural landscape was humanised by the people living within it.

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ENDNOTES

- ¹ Quarterly Report (1 October to 31 December 1837) from Wyatt to the Colonial Secretary, dated 1 January 1838 (Colonial Secretary Reports, 1838/3 & 1838/69, Public Records Office, Adelaide).
- ² Forevidence of Taplin's incorporation of his wife's thoughts and observances see Taplin Journals, 12 September 1860.
- ³ Tindale's journals, field notebooks, and the 'Milerum' manuscript are also important ethnographic sources. This material is housed in the Anthropology Archives, South Australian Museum.
- ⁴ Tindale records that Robert Mason remembered David Unaipon turning up at Swan Reach many years ago, offering 5 shillings for each Aboriginal story he was told (Tindale 1953: 39). Apparently, Ramsay Smith in turn paid him 10 shillings per story he collected. Unaipon collected mythology from Aboriginal contacts he had with communities across South Australia.
- ⁵ For southern South Australia, see Clarke (1990; 1991a: 63–66). Mountford (1958: 144–146, 170–177), & Sims (1978) describe the cultural landscape for the Tiwi of Melville & Bathurst Islands in the Northern Territory.
- ⁶ In the Adelaide region, the Underworld or Land to the West was known by variations of 'Pindi' (Clarke 1991a: 64, 65). In the southern Flinders Ranges it was termed 'Kintyura' (Hercus 1992: 17, 20, 30). It is interesting to note that southern groups believed that the Sun entered the Underworld through diving into the sea, whereas groups near Lake Eyre in Central Australia believed that it disappeared into the ground at a place called 'Dityi-minka', reportedly meaning 'Hole of the Sun' (Howitt 1904: 427, 428).
- ⁷ This is consistent with the individual losing its corporeal identity after death, as noted for the Walbiri in Central Australia (Meggitt 1962: 317).
- ⁸ For instance, see the cosmologies described by Stanbridge (1857), Smyth (1878, vol.1: 430–434), & MacPherson (1882) for northern Victoria, Roth (1903: 7, 8) for northern Queensland, Howitt (1904: 426–434) for south eastern Australia, & Maegraith (1932) for Central Australia.
- ⁹ This is quoted by Cawthorne (1844 [reprint 1926: 24, 25]) without acknowledgment to Teichelmann.
- ¹⁰ Another word in the Adelaide language that referred to sky, heaven, & height is 'karra' (Teichelmann & Schurmann 1840, pt 2: 10).
- ¹¹ Other Parnkalla terms associated with the Skyworld include 'Wangkurtu kurtu' – 'heaven'; 'Pandarrri' – 'sky, heaven'; & 'Walkurri' – 'heaven' (Schurmann 1844, vol.2: 52, 67, 68). The 'sky' or 'ether' was 'ilkari' (Schurmann 1884, vol.2: 6).
- ¹² Foster (1990) discusses the role of the Native Location & Native School.
- ¹³ Other variations include Waieruwar (= Wiyirrewarre), Wiyirri (= Waiyirri) & Wairalt, depending on linguistic context, respectively meaning 'Heaven', 'to Heaven', 'in Heaven'. These variations are illustrated by Taplin (1874 [1879:

- 131]; 1879: 38, 132, 142). See also Tanganekald vocabulary cards, Tindale collection, Anthropology Archives, South Australian Museum.
- ⁴ Penney (as 'Cuique'), *South Australian Magazine*, September 1842, 1(xii): 467–472.
- ¹ Tindale, no date, 'Milerum', Stage A, #6. Anthropology Archives, South Australian Museum.
- ¹⁶ Schurmann's account is similar to Wyatt's but differs in that Monana represents a group of beings, not one individual spirit (Schurmann Diaries 5 June 1839; Wyatt 1879: 166, 181).
- ¹⁷ There are aspects of the Pulyallana mythology that appear to be closely related to the mythology of Ngurunderi in the Lower Murray (Clarke 1995). Both ancestors were chasing their wives across the landscape while creating many of the landforms, eventually drowning the women.
- ¹⁸ The 'Dreamtime' represents an Aboriginal English gloss of a range of meanings. The 'Dreaming' can loosely be defined as the whole body of mythology in Aboriginal Australia that provides some insight into significant cultural events.
- ¹⁹ Schurmann in a newspaper article titled 'The Aborigines of South Australia' in *The South Australian Colonist*, 10 March 1840.
- ²⁰ *Adelaide Register*, 5 October 1887.
- ²¹ According to Tindale (no date, 'Milerum', Stage A, #1, Anthropology Archives, South Australian Museum) the Tangani considered that there were seven stars shaped like a stingray.
- ²² For a destination of the spirit of these warriors see Taplin (1874 [1879: 18], & Meyer (1846 [1879: 201]). A variation in the spelling of Nepeli in the literature is Nepele. Variations of Waiyungari include Wyungare, Wyangaure & Waijungari. Meyer (1843, vol.2: 105) lists 'Waiyungari' simply as the 'name of a star'. Elsewhere, such as south western Victoria, major spirit ancestors were also perceived as living in the Skyworld (Dawson 1881: 49).
- ²³ Schurmann Diaries (5–6 June 1839), & Wyatt (1879: 166, 181). Also see Schurmann in a newspaper article titled 'The Aborigines of South Australia' in *The South Australian Colonist*, 10 March 1840. Monaincherloo also refers to 'a very remote time; ancient' (Teichelmann & Schurmann 1840, vol.2: 25).
- ²⁴ Schurmann Diaries (5 June 1839). Also see Schurmann in a newspaper article titled 'The Aborigines of South Australia' in *The South Australian Colonist*, 10 March 1840.
- ²⁵ Schurmann Diaries (5 June 1839). Also see Schurmann in a newspaper article titled 'The Aborigines of South Australia' in *The South Australian Colonist*, 10 March 1840.
- ²⁶ Clarke (1990; 1991a: 65, 66) outlines early Adelaide Aboriginal beliefs in the afterlife.
- ²⁷ For Christian influences upon Aboriginal culture in southern South Australia, see Berndt & Berndt (1993: 215), & Clarke (1995: 150–152).
- ²⁸ There is much variation in the spelling of this ancestral spirit in the literature (see Clarke 1991: 66–68). This paper follows the standard spelling set by Tindale (1987).
- ²⁹ Teichelmann & Schurmann (1840, vol.2: 41). Also see L. Piesse in a newspaper article titled 'The language of the natives of South Australia' in *The South Australian Colonist*, 14 July 1840. A variation in the recording of 'purli' is 'poulee'.
- ³⁰ Other recorded variations in the Ngaiawang language are 'pidli' (Moorhouse 1843 [1935: 34]). & 'pille' (Tindale 1964: 7).
- ³¹ Schurmann Diaries (22 July 1839), Teichelmann & Schurmann (1840, vol.2: 7, 38, 46), Teichelmann (1841: 9), Wyatt (1879: 166, 167), & Stephens (1889: 500). Also see 'The Transactions of the Statistical Society—Report on the Aborigines of South Australia', *The Southern Australian*, 11 January 1842. Variations recorded for Kakarra include Karkara & Cackera. Teichelmann (1857) also uses the term, Marrero. Tindale (1974: 48, 49) notes that in many parts of Australia, 'Kakara', as the word for Moon or Sun is also used to mean 'the east'. He speculates that this relationship is based on the perception of the east being where these celestial bodies enter the sky.
- ³² The Erawirung people in the Mid Murray region used the term, 'Kakere', for the Moon (Tindale 1930–52: 251). In a coagnatic language, Ngaiawang, the Moon was called 'Kokarar' (Tindale 1964: 5), 'Kakur' or 'Kagurre' (Moorhouse 1843 [1935: 18]). Another word for Moon that Tindale (1953: 7) records for the Mid Murray region is 'Kagura'. It was recorded in the Moorundie area as 'Kokrerer' (Scott 1840–1907).
- ³³ In the Whyalla area of Eyre Peninsula, Bira was perceived as an 'old man from the moon' who killed one of the seven sisters, while chasing the other ones across the landscape (*Advertiser*, 14 April 1990). Schurmann (1884: 3, 57) records the Moon in the Parnkalla language of eastern Eyre Peninsula as 'Pirra'. Similar terms recorded elsewhere in the Central Lakes cultural bloc, such as 'Bira' in the Narangga language of Yorke Peninsula (Black 1920: 86), 'Pira' in Nukunu of the southern Flinders Ranges (Hercus 1992: 2, 8, 27), 'Bera' in Ngadjuri of the Mid North of South Australia, 'Vera' in Wailpi of the Flinders Ranges, & 'Pira' in Dieri of the North East of South Australia (Berndt & Vogelsang 1941: 7).
- ³⁴ To the Ramindjeri, 'Markeri' was also the name of a large shell which resembled a full Moon (Meyer 1843: 78). By another account, the Encounter Bay people called the Moon, 'Mukkeri', & pronounced it very much like the English rendering of 'Mercury' (*Adelaide Observer*, 10 May 1851). Taplin also listed the Moon as 'Markeri' in his Ngarrindjeri vocabularies (1874 [1879: 131]; 1879: 134, 142). The Tanganekald called the Moon, 'Marakari' (Tanganekald vocabulary cards, Tindale collection). In the southern Coorong district, Wells (1852–1855: 112) recorded the Moon as 'Mercuri'.
- ³⁵ A similar account exists in the mythology of northern Victoria, where the main male creative ancestor, Nooralie (= Nureli, Nure:le), commands the Moon to die and the Sun to disappear (Smyth 1878: 431).
- ³⁶ Tindale, no date, loose sheet in 'Milerum', 'Jobs needing further attention before typing.' Anthropology Archives, South Australian Museum.

- ³⁷ Tindale, no date, loose sheet in 'Milerum', 'Jobs needing further attention before typing.' Anthropology Archives, South Australian Museum.
- ³⁸ Smith (1880: 131) lists the Moon as 'Toongoom'.
- ³⁹ Quarterly Report (1 October to 31 December 1837) from Wyatt to the Colonial Secretary, dated 1 January 1838 (Colonial Secretary Reports, 1838/3, Public Records Office, Adelaide).
- ⁴⁰ Schurmann Diaries (5 June & 22 July 1839), Wyatt (1879: 166), Stephens (1889: 501), Williams (1839 [1926: 59]). Also see Schurmann in a newspaper article titled 'The Aborigines of South Australia.' in *The South Australian Colonist*, 10 March 1840. In the Adelaide area, variations in the recording of Tindu include Teendo, Tindo, & Tindoo.
- ⁴¹ Wyatt (1879: 166, 167). Also see letter by Wyatt dated 1 April 1838, from him to the Colonial Secretary. 69/1838. Public Records Office, Adelaide.
- ⁴² Schurmann Diaries, 5 June & 22 July 1839.
- ⁴³ Similar names for the Sun existed across South Australia. It is 'Tjindu' in the Pitjandjara language of Central Australia (Goddard 1992: 151), & in the Wirrangula language of the West Coast (Black 1917: 7; Tindale 1928: 21). It was recorded as 'Tjindo' in Kukatha from the West Coast (Black 1920: 91). In Wongaidya from Baroota in the southern Flinders Ranges it was recorded as 'Dindo' (Black 1917: 12). The Sun was 'Yumo' in the Parnkalla language of eastern Eyre Peninsula (Schurmann 1844, vol.2: 88), 'Thimtu' in Nukunu from the southern Flinders Ranges (Hercus 1992: 28), & 'Tindo' in Narangga of Yorke Peninsula (Black 1920: 89). Similarly, in a cognatic language, Ngadjuri, it was 'Jandu' or 'Djendu' (Berndt & Vogelsang 1941: 9). In the Flinders Ranges, it was termed 'Yuundu' (Berndt & Vogelsang 1941: 9).
- ⁴⁴ *Adelaide Observer*, 10 May 1851. However, 'thulderni' may be a version of the term, 'tulde', recorded by Meyer (1843: 101) to mean a star.
- ⁴⁵ A variation in the recording of Nangge is 'Nungge'. At Currency Creek, an early colonist records that a local European woman, with the name 'Mrs Sunman', was invariably called 'Mrs Nange' by the local Aboriginal people (*Adelaide Observer*, 10 May 1851).
- ⁴⁶ In the Mid Murray area, the Erawirung people used a related term, 'Nanka', for the Sun (Tindale 1930–52: 251). Similarly, the Ngaiawang people used 'Nunka' (Tindale 1964: 7). At Moorundie, it was recorded as 'Nunka' (Scott 1840–1907). Further north at the confluence of the Murray & Darling Rivers, the Maraura people called the Sun, 'Yukku', & dawn 'ngata yukui' (Tindale 1930–52: 251, 253).
- ⁴⁷ For the Mid Murray area, Eyre (1845, vol.2: 365) suggests that an Aboriginal practice of placing stones in trees was to measure time. However, the most likely explanation was that this was to indicate the proximity of water (J. Simpson, pers.com.).
- ⁴⁸ Tanganekald vocabulary cards, Tindale collection. Anthropology Archives, South Australian Museum.
- ⁴⁹ Potaruwutj vocabulary cards, Tindale collection. Anthropology Archives, South Australian Museum.
- ⁵⁰ It is possible that 'kado', 'karo' & 'kardu' are the same linguistic form.
- ⁵¹ Charles White in the *Adelaide Observer*, 14 January 1905.
- ⁵² Tindale, no date, 'Milerum', Stage A, #3. Anthropology Archives, South Australian Museum.
- ⁵³ This trail may have been modified or extended as a result of the building of the Overland Telegraph Line (J. Simpson, pers.com.).
- ⁵⁴ The term 'prolgi', appears to be related to the Australian English term, brolga. This is a borrowing by Europeans from the Kamilaroi language in eastern New South Wales, where it was 'burrallga' (Dixon *et al* 1992: 31, 87, 88, 218). However, other Aboriginal languages from eastern Australia to the Lake Eyre region have similar terms for this bird. The Tangane people of the Coorong called this bird 'porolgi' (Tanganekald vocabulary cards, Tindale collection). The 'native companion' is an early European term for the brolga.
- ⁵⁵ By another account, the Granites near Kingston represented the emus of this myth (Tindale 1931–34: 192). In the South East of South Australia, this myth was sometimes used to identify Aboriginal groups (Tindale letter to Dixon, 6 March 1976, correspondence files, Anthropology Archives, South Australian Museum). The coastal people called themselves Porolgi, while inland groups were Pindjali (= Peindjali).
- ⁵⁶ Schurmann Diaries (12 July 1839), Teichelmann & Schurmann (1840: 19, 47), & Teichelmann (1841: 9). Also see 'The Transactions of the Statistical Society – Report on the Aborigines of South Australia', *The Southern Australian*, 11 January 1842.
- ⁵⁷ Tindale, no date, loose sheet in 'Milerum', 'Jobs needing further attention before typing.' Anthropology Archives, South Australian Museum.
- ⁵⁸ *Adelaide Register*, 5 October 1887.
- ⁵⁹ Tindale, no date, 'Milerum', Stage A, #1. Anthropology Archives, South Australian Museum. This term may relate to the 'Manchinnga', the 'warrior who became a star' (Taplin 1874 [1879: 18]).
- ⁶⁰ For generalised Australian accounts, see Smith (1930: 70, 345–50), & Parker (1953: 105–109). Western Desert accounts are given by Robinson (1966: 91–93), & Isaacs (1980: 152, 153). The 'Seven Sisters inma' is often performed by Western Desert women visiting capital cities for public ceremonies, such as those held at the Tandanya National Aboriginal Cultural Institute in Adelaide.
- ⁶¹ Schurmann Diaries (12 July 1839), Teichelmann & Schurmann (1840, vol.2: 15, 17, 47), Teichelmann (1841: 9). Also see 'The Transactions of the Statistical Society – Report on the Aborigines of South Australia', *The Southern Australian*, 11 January 1842.
- ⁶² The original version appears to be C.C. Hackett in Narrung Alpha, August 1915: 10–12. A later version is Hackett (cited in Laurie 1917: 660–662). See Clarke (1995, endnote 14: 157).
- ⁶³ Tindale, no date, 'Milerum', Stage A, #1. Anthropology

Archives, South Australian Museum. Ngawiri appears to be related to 'ngauwir', meaning boy in the Ramindjeri dialect of Encounter Bay (Meyer 1843: 86).

- ⁶⁴ Also see Tangane-kald vocabulary cards, Tindale collection. As well as Tindale, no date, loose sheet in 'Milerum', 'Jobs needing further attention before typing'. Anthropology Archives, South Australian Museum.
- ⁶⁵ It is possible that there were several constellations termed Yuki by the Lower Murray people, as this term is applied to canoes (cf. Milky Way). In the Yarlaldi dialect, the Southern Cross constellation was termed Tjirilengi (McDonald 1977).
- ⁶⁶ Tindale, no date, loose sheet in 'Milerum', 'Jobs needing further attention before typing'. Anthropology Archives, South Australian Museum. Stanbridge (1857) provides a similar myth concerning Lyra, which represents a lowan flying.
- ⁶⁷ Tindale, Aboriginal Place Name File, Anthropology Archives, South Australian Museum.
- ⁶⁸ Tindale, Aboriginal Place Name File, Anthropology Archives, South Australian Museum. A creek near Yankalilla in the southern Fleurieu Peninsula area is known as Parananacooka. According to Tindale, this was a rendition of the Aboriginal forms, Paranankuka and Paranankuna. Its translation was said to refer to the excreta and urine of the Autumn Star, which explained why this creek becomes very brackish at the end of summer. However, given his word derivation, this appears to be unlikely on linguistic grounds (J. Simpson, pers.com.).
- ⁶⁹ Schurmann Diaries (5 June 1839). Also see Schurmann in a newspaper article titled 'The Aborigines of South Australia' in *The South Australian Colonist*, 10 March 1840.
- ⁷⁰ 'The Transactions of the Statistical Society – Report on the Aborigines of South Australia', *The Southern Australian*, 11 January 1842. Another reference is Moorhouse in 'Report on the Aborigines of South Australia' 14 October 1843, Document no. 1234, GRG 24/6, Public Record Office. In the Narangga language of Yorke Peninsula, a shooting star was 'wajaga' (Black 1920: 89).
- ⁷¹ Tangane-kald vocabulary cards, Tindale collection, Anthropology Archives, South Australian Museum.
- ⁷² Schurmann Diaries (5 June 1839). Also see Schurmann in a newspaper article titled 'The Aborigines of South Australia' in *The South Australian Colonist*, 10 March 1840.
- ⁷³ The inclusion of the Rufus River in this explanation was possibly due to it being the site of a massacre of Aboriginal people by overlanders in 1842 (see Moorhouse correspondence to Colonial Secretary, reproduced by Taplin 1879: 115–123).
- ⁷⁴ Schurmann (1844, vol. 2: 79) suggested that in the Parnkalla language of eastern Eyre Peninsula the term for comet was 'yandarri'.
- ⁷⁵ 'The Transactions of the Statistical Society – Report on the Aborigines of South Australia', *The Southern Australian*, 11 January 1842. Another reference by Moorhouse is in 'Report on the Aborigines of South Australia', 14 October 1843, Document no. 1234, GRG 24/6, Public Record Office.

THREE NEW BEROBUS LEACH (COLEOPTERA: HYDROPHILIDAE) FROM AUSTRALIA

C. H. S. WATTS

Summary

Three new species of *Berosus* Leach are described from Australia: *B. sonjae*, *B. sarahae* and *B. wadeae*. Specimens of *B. wadeae* came from the Lake Eyre Basin region of South Australia and those of *B. sarahae* and *B. sonjae* from the Cairns and Townsville regions of north-east Queensland.

THREE NEW *BEROSUS* LEACH (COLEOPTERA : HYDROPHILIDAE) FROM AUSTRALIA

C. H. S. WATTS

WATTS, C. H. S. 1996. Three new *Berosus* Leach (Coleoptera: Hydrophilidae) from Australia. *Records of the South Australian Museum* 29(2): 147–152.

Three new species of *Berosus* Leach are described from Australia: *B. sonjae*, *B. sarahae* and *B. wadeae*. Specimens of *B. wadeae* came from the Lake Eyre Basin region of South Australia and those of *B. sarahae* and *B. sonjae* from the Cairns and Townsville regions of north-east Queensland.

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This paper describes two distinctive new *Berosus* which I came across whilst sorting specimens in the South Australian Museum collection (SAMA) and one collected recently in Queensland by my son. The tropical members of this genus in Australia are still poorly known and difficult to separate using the key given in Watts (1987). The three new species described here are however readily separated from any known species, warranting their description without an extensive revision of the genus.

SYSTEMATICS

Berosus wadeae sp. nov.
(Figs 3, 4)

Description (number examined, 26)

Length 5.0 – 6.5 mm. Elongate-oval, not hump-backed, apex of elytron slightly elongate with one short but well marked spine a little distance from suture line (in position of outer spine in species with a pair of apical spines on elytron). Elytron yellow-brown, portions of striae darker, in a few places tending to spread to adjoining striae forming a darker patch on elytron; base of head narrowly black; appendages reddish-brown; ventral surface dark brown to black with apical ventral segment lighter in some specimens. Punctures on head, well marked, weaker and sparser in front, strong and longitudinally elongate behind. Pronotum densely covered with large strong punctures, those on disc longitudinally elongated to about twice as long as wide. Elytron with deeply impressed striae, obliterating the serial punctures except towards back; dorsal

surface covered with short stout setae (often abraded off) arising from shallow, very rugose, confluent punctures giving the interstitial regions of the elytron an evenly rugose appearance which all but obscures the punctation. Ventral surface densely but finely punctured, each puncture with a short setae. Mesosternum with a weak midline keel projecting backward as a spine between mesocoxae. Midline of first ventral abdominal segment weakly keeled in extreme front. Metacoxal process raised, sharply triangular (diamond shaped area in midline shiny and devoid of sculpture). Rugose portions of meso and metafemora half to two thirds the length of respective femora, that on profemur one third length of profemur.

Male

Protarsi four-segmented, basal segment weakly expanded, about twice as long as wide and as long as second and third segment combined, second segment weakly expanded, as long as simple third segment. Male aedeagus as in figs 3 and 4.

Remarks

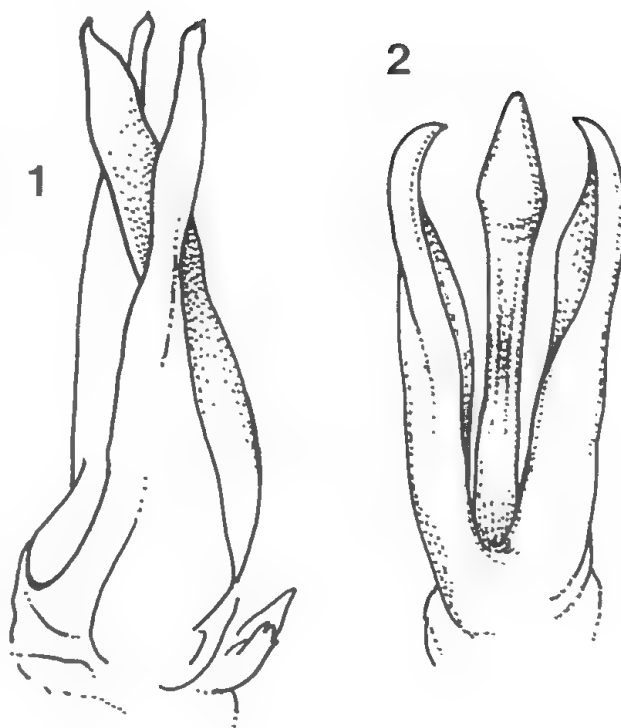
At first glance *B. wadeae* can be easily confused with the widespread and common *B. nutans* W. MacLeay which occurs in the same region. It differs from this species in several characteristics: the elytral striae are weakly impressed in *B. nutans*, strongly impressed in *B. wadeae*; the tips of the elytra are rounded in *B. nutans*, spinose in *B. wadeae*; the pronotal punctures in *B. wadeae* are strong and tend to be elongated longitudinally, in *B. nutans*, they are

small, transversely elongated and interconnected by a network of transverse grooves.

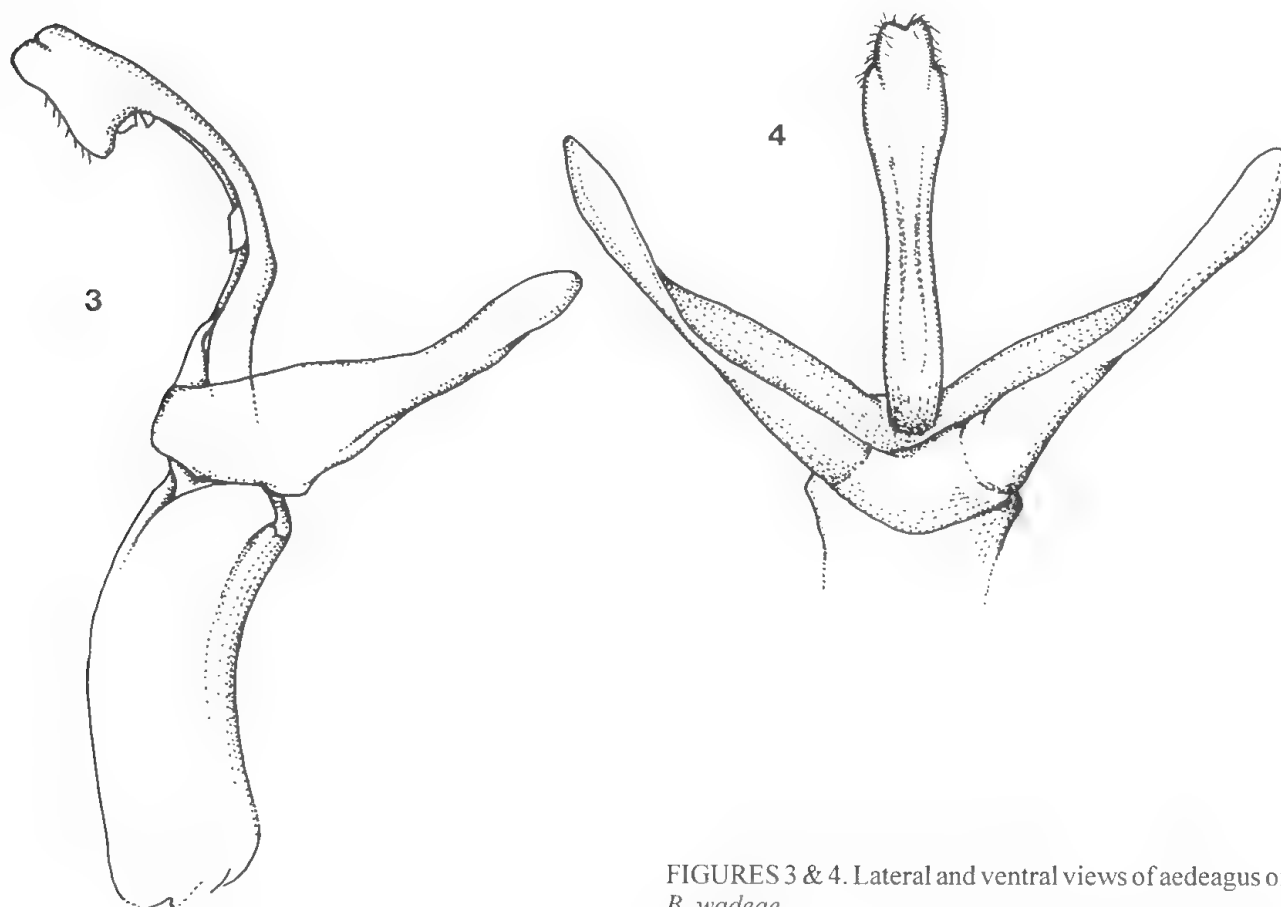
B. wadeae is similar to *B. dallasi* Watts but is larger and broader, the elytral striae are sharper and a little larger and the dark colour on the head of *B. dallasi* is more extensive and not restricted to the basal margin as in most *B. wadeae*. The clearest separation is in the form and strength of the punctures on the head and pronotum. In *B. dallasi* these are moderately strong, sometimes a little longitudinally elongated but seldom confluent. In *B. wadeae* the pronotal punctures on the disc and those on the rear half of the head are strong, virtually confluent, longitudinally elongated to the extent that they form longitudinal grooves, particularly deep on the disc of the pronotum. In some *B. wadeae* there is also a longitudinal groove in the midline of the pronotum. The aedeagi of the two species are distinctive (Figs 3 & 4 and Watts 1987).

Distribution

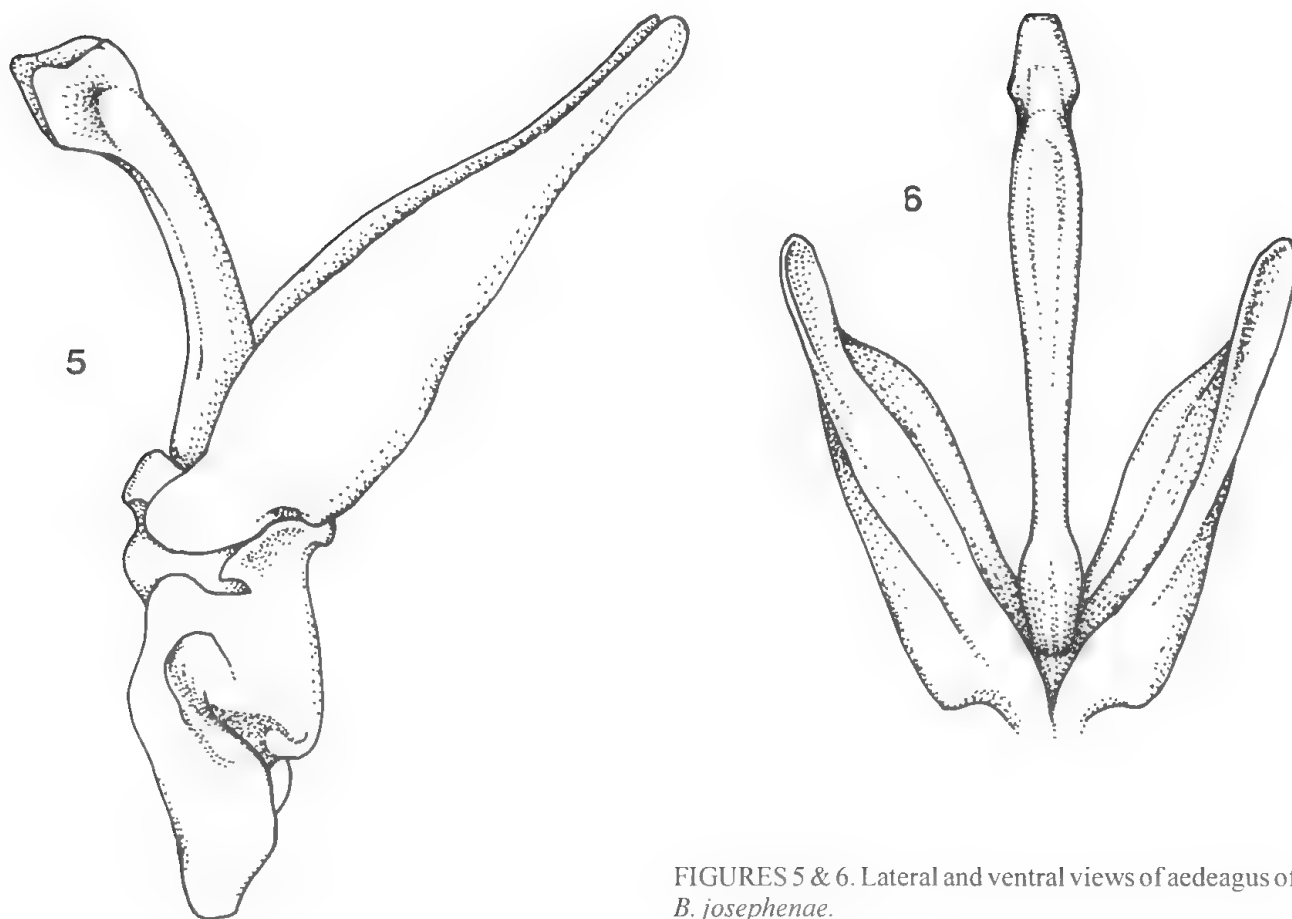
Known from Marree, Big Perry Springs, Clayton Crossing and Coward Springs, all localities in the southern Lake Eyre basin in South Australia.



FIGURES 1 & 2. Lateral and ventral views of apical portion of aedeagus of *B. sarahae*.



FIGURES 3 & 4. Lateral and ventral views of aedeagus of *B. wadeae*.



FIGURES 5 & 6. Lateral and ventral views of aedeagus of *B. josephenae*.

Types

Holotype: Male. 'S. Aust. at light. Levi Crk. 8 km NW, Big Perry Springs. 28°, 19.2' 136°, 16.1, 7 Dec. 1974 J.A. Herridge'; in SAMA.

Paratypes: Eighteen, same data as Holotype, in SAMA; 1, 'S. Aust. at light. Marree Racecourse. 1 Dec. 1974. J.A. Herridge'; 5, 'Clayton Crossing, S.A. 13 November 1955. At light. E. T. Giles'; 1, 'S. Aust. Coward Springs. At light. 9 Nov. 1965, G. F. Gross', all in SAMA.

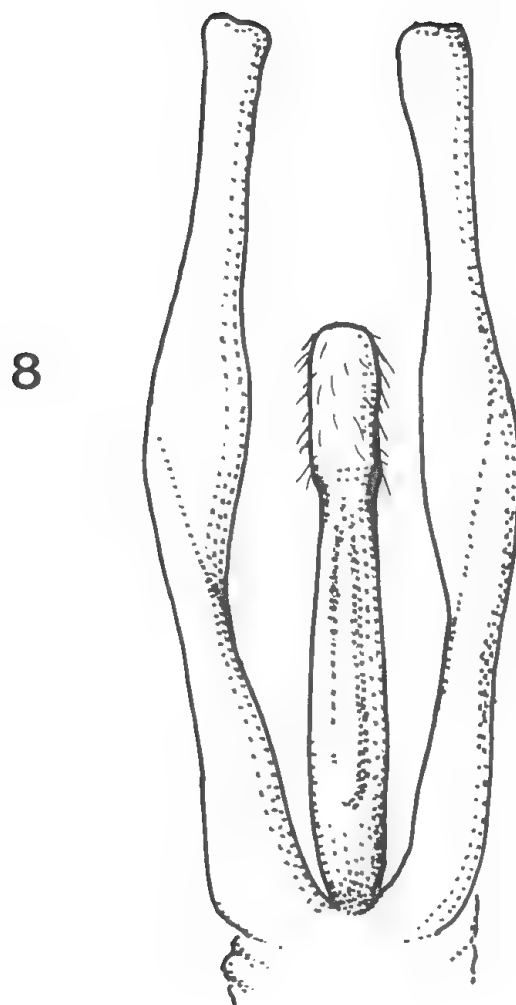
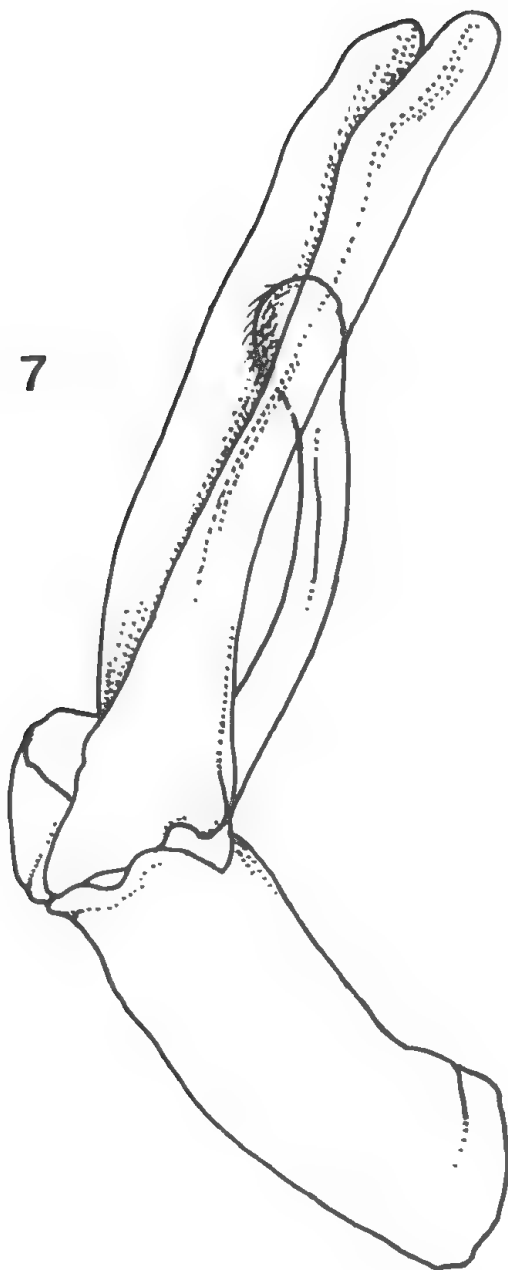
Berosus sarahae sp. nov.

(Figs 1, 2)

Description (number examined, 11)

Length 3.5 – 4.5 mm. Oval, widest in the middle of the elytra. Elytra not, or only weakly, humped. Apex of elytron bluntly pointed. Head relatively broad, red-brown, lighter towards the front. Pronotum red-brown, with two broad longitudinally darker bands in the middle. Elytra red-brown, sutural lines dark brown-black, more marked on disk than on sides, several poorly marked dark spots, the most prominent near

sutural line behind middle. Ventral surface and appendages light red-brown. Punctures on head strong, moderately dense, those on front of head denser but not much smaller than those on the rest of the head. Pronotal punctures moderately and rather evenly covered with moderate sized punctures, stronger and denser laterally, a narrow central longitudinal strip impunctate. Pronotum covered with a fine reticulation. Elytral striae grooved, stria punctures, moderately distinct, longer and sparser towards the sides, the groove sharply defined only on inner edge. Interstria punctures much smaller than those in adjacent striae, relatively sparse and shallowly impressed. Second elytral striae often lacking groove (as does adjacent basal portion of first stria), consisting of an unevenly spaced row of 5–10 serial punctures some of which may be joined. Elytra covered with a fine reticulation as on pronotum. Metacoxal plates and abdominal sterna covered with strong, dense, rugose punctures. Midline of mesosternum with strongly raised keel, ventral edge flat and slightly concave. Midline of first abdominal sternite keeled. Front edge of metacoxal plates quite strongly ridged. Metacoxal process produced



FIGURES 7 & 8. Lateral and ventral views of aedeagus of *B. sonjae*.

backwards into small spine in midline, central lobes raised, weakly diverging anteriorly, small oval to diamond shaped impunctate depression in midline. Rugose portion of metafemur half to two thirds length of femur, that of mesofemur about half the length and that of profemur a little less than half the length of femur. Apical abdominal sternite deeply and widely notched.

Male

Protarsi four segmented, first segment moderately expanded.

Remarks

The species clearly belongs in the *B. approximans* group of Australian *Berosus* by

virtue of its general size and shape, strongly keeled mesosternum and first abdominal sternite, short second elytral striae and notched apical sternite in both sexes. It however lacks the black metallic head found in all other group members. Its light red-brown ventral surface and strong ventral punctures also separate it from other members of the group (*B. approximans* Fairmaire, *B. discolor* Blackburn, *B. juxtadiscolor* Watts, *B. reardoni* Watts and *B. timmsi* Watts) which all have dark-brown to black ventral surfaces and weaker ventral punctation.

Distribution

Kuranda and Cairns district, North Queensland.

The Cairns district specimens were taken at light, the Mt Molloy specimens in 100–300 cm deep water in a seasonal swamp.

Types

Holotype: Male. 'Cairns dist. A.M. Lea', in SAMA.

Paratypes: 9, same data as holotype, in SAMA; 1, 'Kuranda Queensland, Griffith Collection, Id by A.M. Lea', in SAMA; 7, '2 km N Mt Molloy, Qld, 30.3.96, C. Watts', in SAMA.

Berosus sonjae sp. nov.

(Figs 7, 8)

Description (number examined, 13)

Length, 4.5–5.5 mm. Elongate oval, not hump-backed, apex of elytron with strong outer spine, lacking inner spine. Elytron yellow-brown, portions of stria and punctures darker, stronger in a few places giving elytron two–three vague darker broad bands. Ventral surface, other than appendages darker, rugose portions of femora same yellow-brown colour as rest of leg. Punctures on head strong, those towards rear tending to form longitudinal rows in some specimens, weaker and sparser in front. Pronotum evenly covered with large, round, even-sized

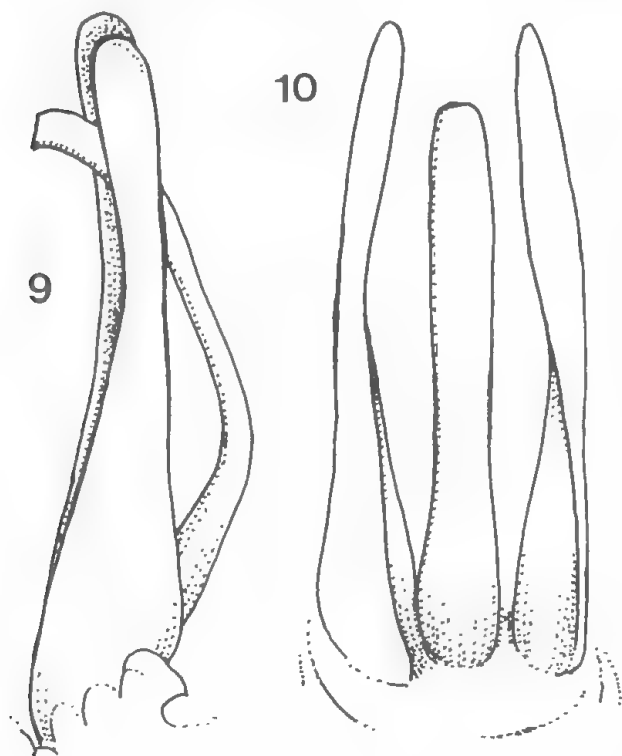
punctures most $1/4$ and $1/2$ a puncture width apart. Elytral striae well impressed, almost masking punctures in many places, punctures becoming much larger towards apex and sides, interstitial punctures setose, rather shallow particularly at sides where they become subobsolete, about half the size of those on pronotum, in most interstriae arranged in one loose row. Ventral surface densely rugose-punctate except for small diamond-shaped portion in centre of metasternum. Mesosternum with weak midline keel, metasternum with short, weak, midline keel anteriorly. Hind margin of apical (5th visible) sternite broadly and shallowly concave. Midline of first sternite weakly keeled in extreme front. Metacoxal process raised, triangular. Rugose portions of meso- and metafemur $2/3$ to $3/4$ length of femur, that on profemur somewhat less.

Male

Protarsi four segmented, basal segment a little swollen, about length of second and third segments combined, second and third segments same length in dorsal view, third longer in lateral view, not enlarged, total length about equal to length of tibia. Male genitalia with short aedeagus (Figs 7 & 8).

Remarks

Berosus sonjae belongs to the section of Australian *Berosus* characterised by the lack of a strong mesosternal pillar, normal elytral punctation, and uniform and relatively large punctures on pronotum (*B. amoenus* Watts, *B. josephenae* Watts and *B. gibbae* Watts). It can be separated from all of these by the distinctive male genitalia which has the aedeagus much shorter than the parameres, the tips of which are truncated (Figs 5–10) (When I first saw the aedeagus I assumed I had damaged it in the extraction but further dissections proved this wrong). In addition to the difference in the male genitalia it can be separated from *B. amoenus* by its yellow-brown rather than black head; from *B. josephenae* by its lighter coloured femora, and by the lateral interstitial punctures which are hard to trace and often marked only by setae, whereas in *B. josephenae* they are large but shallow and almost twice the diameter of those on disc; from *B. gibbae* in being somewhat larger, with rather closer and more regular punctation on pronotum, lack of a well marked fine reticulation on elytra and its elytral striae tending to be more deeply impressed.



FIGURES 9 & 10. Lateral and ventral views of apical portion of aedeagus of *B. gibbae*.

Distribution

Known only from the type locality in North Queensland. All specimens were taken at light.

Types

Holotype: Male. 'Qld. 70km SW Greenvale 16–28 Jan 95 A. J. Watts', in SAMA.

Paratypes: 4 same data as Holotype, in SAMA; 8 same data as Holotype except 15–24 Feb 95, in SAMA; 2, same data as holotype except 29 Dec – 13 Jan 96, in SAMA.

ACKNOWLEDGMENTS

I would like to thank Rob Gutteridge for the excellent drawings, Vicki Wade and Robyn Cherrington for typing the manuscript.

REFERENCE

WATTS, C. H. S. 1987. Revision of Australian *Berosus* Leach (Coleoptera : Hydrophilidae). *Records of the South Australian Museum* **21**(1): 1–28.

NEW SPECIES OF PEDIANA (HETEROPODIDAE : ARANEAE) SIMON FROM CENTRAL AND NORTHERN AUSTRALIA

DAVID B. HIRST

Summary

Four new species of Peditana Simon, *P. longbottomi*, *P. paradoxa*, *P. temmei* and *P. webberae*, are described from central and northern Australia. All exhibit characters which uniquely bond them as a further group within the genus Peditana. A new locality record for *P. regina* (L. Koch) and revised key to species are given.

NEW SPECIES OF *PEDIANA* (HETEROPODIDAE: ARANEAE) SIMON FROM CENTRAL AND NORTHERN AUSTRALIA.

DAVID B. HIRST

HIRST, D. B. 1996. New species of *Pediana* (Heteropodidae: Araneae) Simon from central and northern Australia. *Records of the South Australian Museum* 29(2): 153–164.

Four new species of *Pediana* Simon, *P. longbottomi*, *P. paradoxa*, *P. temmei* and *P. webberae*, are described from central and northern Australia. All exhibit characters which uniquely bond them as a further group within the genus *Pediana*. A new locality record for *P. regina* (L. Koch) and revised key to species are given.

D. B. Hirst, South Australian Museum, North Terrace, Adelaide, South Australia, 5000.
Manuscript received 1 March 1996.

The genus *Pediana* Simon, 1880 was revised by Hirst (1989) with the redescription of the four known Australian species and later Hirst (1995) described a further species from one female from south-western Northern Territory. Material received since from the Northern Territory Museum, the Western Australian Museum and other material discovered in or collected recently for the South Australian Museum collection, contained four more species of *Pediana* remarkably distinct from those previously known.

Pediana was considered (Hirst 1989) to have a relatively high convex carapace, a pointed dorsal ridge on the male tibial apophysis, and female spermathecal sacs, when present, extended posteriorly under the fossa. Unique characters found in the new species, males sometimes lacking a pointed dorsal ridge on the tibial apophysis, a low posterior carapacial area sometimes present in the female, anteriorly directed spermathecal sacs of known females and spinnerets positioned subapically on a more elongate abdomen of all species have necessitated amendments to the generic diagnosis (see below). A new group, the *webberae* group, is erected for the new species and contains two species-pairs.

MATERIALS AND METHODS

Leg indices are leg length excluding coxa and trochanter divided by length of carapace. The penultimate stage and poor condition of the male of *P. webberae* do not allow for adequate comparative measurements and these are kept to a minimum. Other materials and methods are given in Hirst (1989, 1991). Abbreviations. *Institutions*:

NTM, Northern Territory Museum; SAMA, South Australian Museum, Adelaide; SMF, Natur-Museum Senckenberg, Frankfurt, Germany; WAM, Western Australian Museum, Perth. *Morphology*: AE, anterior eyes; PE, posterior eyes; MOQ, median ocular quadrangle; L or l, length; W, width. Other abbreviations used in description are standard for the Araneae.

SYSTEMATICS

Genus *Pediana* Simon

Pediana Simon, 1880: 258. For full synonymy list see Hirst 1989: 113.

Diagnosis

Carapace relatively high; flat above and declivity posterior to fovea or rarely with declivity anterior of fovea. ALE largest, occasionally males with AME largest; AE row recurved, PE row procurved; lateral eyes raised on low common mound; MOQ longer than wide or occasionally wider than long. Legs 2143 or 1243, anterior pairs being subequal. Abdomen oval with spinnerets apical or elongate and reaching more than twice as long as wide, obtusely pointed posteriorly with spinnerets subapical at least in females. Male palp with embolus coiled once or two and a half or five times, coil stack wide and of low profile. Palpal tibia with large retrolateral distal apophysis having a raised dorsal basal ridge or ridge not raised but extended dorsally on tibia. Spermathecal sacs projecting to posterior or to anterior, or absent.

REVISED KEY TO SPECIES OF *PEDIANA* OF AUSTRALIA

Female

- 1 — Abdomen elongate, bluntly pointed posterior, spinnerets subapical (Fig. 3) 2
 — Abdomen oval, rounded posterior, spinnerets apical 4
- 2 — Carapace relatively flat; spermathecal sacs originate from posterior of fertilization duct 3
 — Carapace with steep declivity anterior of fovea; spermathecal sacs originate anterior of fertilization duct *webberae*, sp. nov.
- 3 — Dorsal carapacial and abdominal stripe lacking (Fig. 15) *temmei*, sp. nov.
 — Dorsal carapacial and abdominal stripe present (Fig. 20) *paradoxa*, sp. nov.
- 4 — Anterior tibiae usually with 1 dorsal spine and 2 ventral spine pairs; insemination ducts lightly sclerotised with 2–4½ coils, spermathecal sacs present 5
 — Anterior tibiae usually with 2 dorsal spines and 3 ventral spine pairs; insemination ducts heavily sclerotised with 5 coils, spermathecal sacs absent 7
- 5 — Venter of abdomen with yellow setae, bases of femora not black ventrally 6
 — Venter of abdomen with orange setae, bases of femora black ventrally
 *regina* (L. Koch)
- 6 — Leg femora conspicuously spotted, legs and body with variably coloured setae, epigynum small, insemination ducts with 2½ coils
 *occidentalis* Hogg
 — Leg femora inconspicuously spotted, legs and body with yellow-white setae, epigynum relatively large, insemination ducts with 4½ coils *mainae* Hirst
- 7 — Anterior femora with white spots; epigynum broad posteriorly *horni* Hogg
 — Anterior femora reddish ventrally; epigynum narrows posteriorly *tenuis* Hogg

Male

- 1 — Embolus with 1–1¼ coils 2
 — Embolus with 2½ coils or more 3

- 2 — Carapace 3–4x longer than high with slight declivity anterior of fovea (Fig. 7); tibial apophysis with raised dorsal ridge (Fig. 9)
 *webberae*, sp. nov.
 — Carapace 5x longer than high, flat (Fig. 10); tibial apophysis lacking raised dorsal ridge at base of apophysis (Fig. 13)
 *longbottomi*, sp. nov.
- 3 — Embolus with 2½–2¾ coils 4
 — Embolus with 5 coils 7
- 4 — Abdomen elongate (L = 2x W); median apophysis extends away from base of embolus (Fig. 18) 5
 — Abdomen rounded or oval (L = 1½x W); median apophysis adjacent base of embolus (Hirst 1989; fig. 6) 6
- 5 — Dorsal carapacial and abdominal stripe lacking; dorsal ridge of tibial apophysis with apex curved (Fig. 19) *temmei*, sp. nov.
 — Dorsal carapacial and abdominal stripe present; dorsal ridge of tibial apophysis with apex straight (Fig. 25)
 *paradoxa*, sp. nov.
- 6 — Embolic base with small median apophysis *regina* L. Koch
 — Embolic base with broad median apophysis *occidentalis* Hogg
- 7 — Dorsal ridge of tibial apophysis with apex curved *horni* Hogg
 — Dorsal ridge of tibial apophysis with apex straight *tenuis* Hogg

Pediana webberae, sp. nov.
 (Figs 1–9, 26; Table 1)

Types

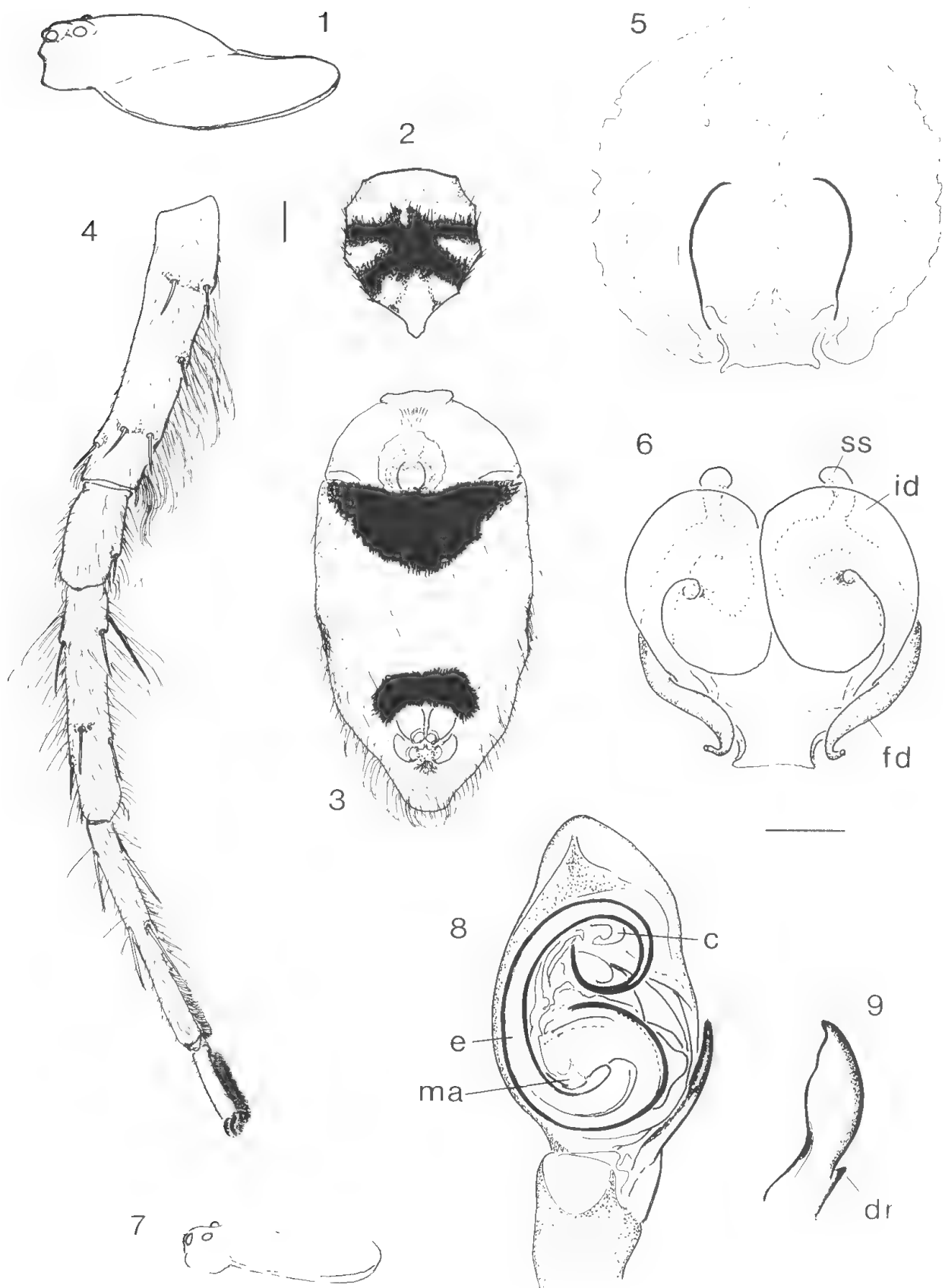
Holotype ♀, Darwin, (12°27'S 130°50'E), Northern Territory, Dec. 1992, J. Webber, NTM A–81.

Non-type

♂, no data, SAMA N1994649.

Diagnosis

Colour and pattern typical for *Pediana* species. Carapace with declivity anterior of fovea; AME of male may be largest; posterior eyes relatively small, subequal; MOQ wider than long. Leg spine bases raised on low mound at least on femora;



FIGURES 1-9. *Pediana webberae*, sp. nov. 1-6, holotype female. 1, carapace, lateral; 2, sternum; 3, abdomen, venter; 4, leg IV, right dorsal; 5, epigynum, cleared; 6, vulva, dorsal. 7-9, male. 7, carapace, lateral; 8, left palp cymbium and tibia, ventral; 9, tibial apophysis, retrolateral. Scale lines; Figs 1-4, 7, 1mm, Figs 6, 8, 9, 0.5mm. c, conductor; dr, dorsal ridge; e, embolus; fd, fertilization duct; id, insemination duct; ma, median apophysis; ss, spermathecal sac.

posterior legs with brushes of long setae proventrally. Male embolus with just over 1 complete coil. Female epigynum relatively large, spermathecal sacs project anteriorly, insemination ducts with 1¼ lightly sclerotised coils.

Description

Female. CL 7.48, CW 7.47. AL 9.15, AW 4.90.

Colour in alcohol: Carapace red-brown, striae darker, numerous short black setae; caput dark in ocular area, white and yellow setae; clypeus with orange setae. Chelicerae red-brown, long yellow setae, basal half with short white setae. Maxillae and labium black but anterior margin pale. Sternum; anterior orange with long orange setae, medially with black 'x' pattern (Fig. 2), posterior tip yellow. Legs yellow, femora I–III ventrally with 2 rows of white spots formed of short adpressed setae; posterior legs with numerous long setae on tibia III, femur, tibia and metatarsi IV. Abdomen dorsum and venter (Fig. 3) typical.

Eyes: AME 0.48. AME: ALE: PME: PLE = 1: 1.04: 0.67: 0.69. Interspaces; AME–AME 0.65, AME–ALE 0.50, PME–PME 1.98, PME–PLE 1.69, AME–PME 1.35, ALE–PLE 1.21. MOQ, aw: pw: l = 2.65: 3.31: 3.02. Width of clypeus to AME 0.61.

Labium: L 1.02, W 1.47. Sternum: L 3.79, W 3.08.

Legs: (Table 1) Anterior leg indices; I = 3.6, II = 3.5.

Spination: As for the *P. horni* group but, tibiae III and IV have 2 dorsal spines, tibia IV lacks the distal ventral spine pair.

Epigynum: Lateral rim rounded anteriorly; anterior of fossa recessed. Vulva with small spermathecal sacs projecting from anterior of fertilization duct (Fig. 5), insemination ducts with 1¼ lightly sclerotised coils (Fig. 6).

Male. CL 4.78, CW 4.41. AL 7.65, AW 3.00.

Outer skin lifted in readiness for the sloughing process. Most setae lost from outer skin. Caput lower with only a gradual declivity to fovea (Fig. 7); AME appear largest on adult skin but

asymmetrical due to softness; posterior of abdomen less rounded than in the female, extending in a point beyond spinnerets; leg femora not as obviously tuberculate.

Colour in alcohol: As in female but faded. Corresponding areas of black on female are brown on the male.

Palps: Unhardened pre-moult condition, although fully formed under epidermis final shape and position of various sclerites within cymbium may not be complete; conductor originates prodistally as in the *regina* group but instead of having two coils is short with a curled tip; embolus with a little over 1 coil (Fig. 8); tibial apophysis more than 2x length of tibia, broad with straight pointed dorsal ridge on base (Fig. 9).

Distribution

Known only from Darwin, Northern Territory (Fig. 26).

Remarks

The male is excluded from the type material. It is assumed to have been collected at the beginning of this century and is in poor condition. It is penultimate but removal of the outer epidermis reveals a soft, yet apparently fully formed adult beneath. Although the carapace shape and tuberculate leg femora closely associate the male with the female of *P. webberae* it is not unequivocally conspecific. The male of *P. webberae* differs from *P. longbottomi* in the carapace shape, the tuberculate leg femora, in having a pointed dorsal ridge at the base of a broader palpal tibial apophysis and smaller venter badge markings. *P. webberae* further differs from *P. temmei* and *P. paradoxa* in the male embolic coils and female spermathecal sacs.

Etymology

The species is named after Ms J. Webber (NTM), collector of the holotype.

Pediana longbottomi, sp. nov.

(Figs 10–13, 26; Table 2)

Type

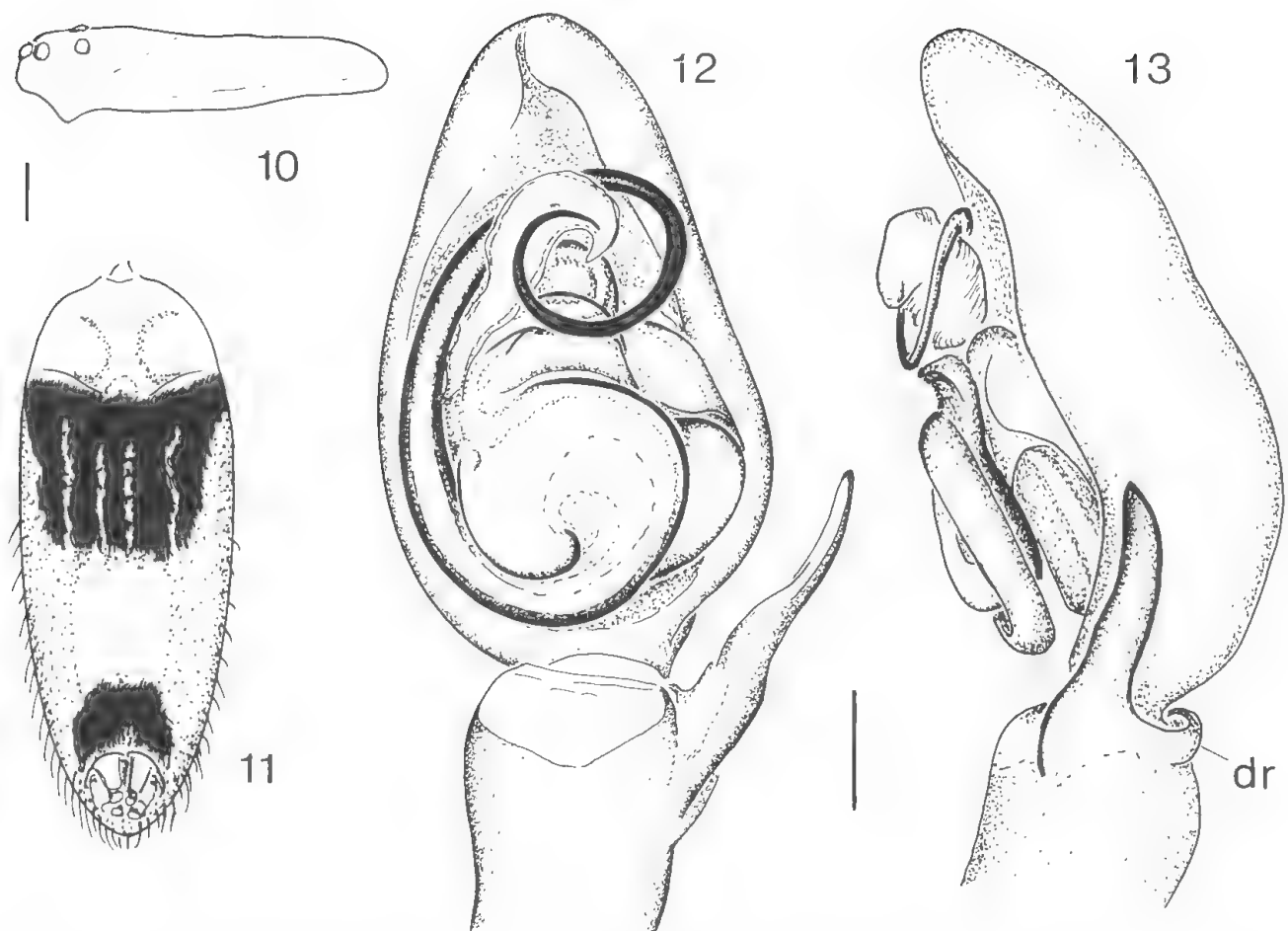
Holotype ♂, Drysdale River Stn (15°42'S 126°22'E), Xavier River area, Western Australia, 8–12.ix.1993, A.F. Longbottom (S.1366), WAM 94/1673.

Non-types

Juvenile, same data as holotype but (S.1367),

TABLE 1. Leg measurements of *Pediana webberae*, sp. nov. Values are for holotype female

	Leg 1	Leg 2	Leg 3	Leg 4	Palp
Femur	8.12	8.09	5.79	7.64	2.85
Patella	3.24	3.23	2.62	2.71	1.42
Tibia	6.45	6.29	4.78	5.69	1.51
Metatarsus	6.58	6.22	3.89	5.88	—
Tarsus	2.21	2.14	1.73	1.96	2.20
Total	26.60	25.97	18.81	23.88	7.98



FIGURES 10–13. *Pediana longbottomi*, sp. nov. Male. **10**, carapace, lateral; **11**, abdomen, venter; **12–13**, left palp cymbium and tibia, **12**, ventral; **13**, retrolateral. Scale lines; Figs 10–11, 1mm, Figs 12–13, 0.5mm. dr, dorsal ridge.

WAM 94/1675; juv., same data as holotype but Diamond Waterhole, 1.viii.1993, amongst vegetation, (S.1311), WAM 94/1674.

Diagnosis

Male: Colour and pattern typical for *Pediana* species but venter with large black patches. Carapace flat. AME largest, PME relatively small. Leg femora not conspicuously tuberculate. Tibial apophysis relatively narrow with long low ridge extending to dorsal of tibia; embolus with $1\frac{1}{4}$ coil. Female unknown.

Description

Male. CL 6.03, CW 4.91. AL 8.92, AW 3.74.

Colour in alcohol: Carapace and chelicerae red-brown, short black, grey and orange setae, adpressed on carapace, upright on chelicerae. Maxillae and labium dark brown. Sternum dark brown but posterior tip pale. Legs brown; brown-black stout setae and adpressed fine white setae; spines on femora short, weak. Abdomen dorsally

typical; venter with large black patches (Fig. 11).

Eyes: AME 0.42. AME: ALE: PME: PLE = 1: 0.95: 0.69: 0.79. Interspaces; AME–AME 0.36, AME–ALE 0.07, PME–PME 0.98, PME–PLE 1.26, AME–PME 1.02, ALE–PLE 1. MOQ, aw: pw: 1 = 2.36: 2.36: 2.71. Width of clypeus to AME 0.60.

Labium: L 0.92, W 1.08. Sternum: L 3.01, W 2.43.

Legs: (Table 2) Anterior leg indices; I = 5.6, II = 5.5.

TABLE 2. Leg measurements of *Pediana longbottomi*, sp. nov. Values are for holotype male

	Leg I	Leg 2	Leg 3	Leg 4	Palp
Femur	10.08	9.92	6.89	9.78	2.16
Patella	3.16	3.13	2.43	2.55	1.03
Tibia	9.03	9.04	6.19	8.09	1.22
Metatarsus	8.81	8.45	5.06	8.82	–
Tarsus	2.60	2.75	1.82	2.27	2.34
Total	33.68	33.29	22.39	31.51	6.75

Spination: As for the *P. horni* group, but tibia IV lacking the distal ventral spine pair.

Palps: Embolus with $1\frac{1}{4}$ coil (Fig. 12), embolic base with high distal ridge; tibial apophysis with low ridge extending to dorsal of tibia (Fig. 13).

Distribution

Known only from Drysdale River Station in Western Australia (Fig. 26).

Remarks

P. longbottomi differs from all known male *Pediana* in lacking a sharply raised dorsal ridge to the tibial apophysis base. It further differs from *P. webberae* in the male tibial apophysis being narrower, in having the embolic base extended distally and larger ventral abdominal black patches. In the male of *P. longbottomi* the posterior of the abdomen (Fig. 11) is less extended and the legs are not so markedly tuberculate as in *P. webberae*. However, two juveniles from the same locality possess those characters indicating that they may also be present in the female *P. longbottomi*. Those juveniles do not have a high caput with steep declivity anteriorly to fovea, nor do they possess brushes of setae on leg IV.

Etymology

The species is named after Mr A. F. Longbottom who collected the material.

Pediana temmei, sp. nov.

(Figs 14–19, 26; Table 3)

Types

Holotype ♂, 9.5 km SSE Ampeinna Hills, (27°09'S 131°09'E), South Australia, 22.iii.1995, D. Hirst, SAMA N19951.

Allotype ♀, 11.5 km SSW of Ampeinna Hills, (27°11'S 131°05'E), South Australia, 24.iii.1995, D. Hirst, SAMA N19952.

Paratypes; ♀, same data as allotype, SAMA N19953; 2 ♂, 10 km E of Ampeinna Hills, (27°05'S 131°13'E), South Australia, 23.iii.1995, D. Hirst, SAMA N19954–5.

Diagnosis

Colour grey or grey-black, venter of abdomen lacks conspicuous black patch anterior to spinnerets. Carapace highest posteriorly. ALE largest. Leg femora spines short except distally. Abdomen extended posteriorly beyond spinnerets in female. Male embolus with $2\frac{1}{2}$ coils; dorsal

ridge of tibial apophysis with curved apex. Female spermathecal sacs small, projecting anteriorly from beneath anterior sector of fossa; insemination ducts with $2\frac{1}{4}$ lightly sclerotised coils.

Description

Male. CL 4.34, CW 3.76. AL 4.31, AW 2.10.

Colour in alcohol: Carapace brown, ocular area darker, numerous uniform short black, white and orange setae. Chelicerae red-brown, long white setae. Maxillae and labium brown-black. Sternum; brown with black suffusion, grey setae. Coxae and most part of legs yellow-brown with black suffusion, legs III darker; anterior femora ventrally with white spots formed of short adpressed setae; long setae on legs not numerous. Abdomen somewhat shrunk; venter with black patch posterior to epigastric furrow, few black spots medially, suffusion anterior of spinnerets.

Eyes: AME 0.34. AME: ALE: PME: PLE = 1: 1.15: 0.82: 0.88. Interspaces; AME–AME 0.32, AME–ALE 0.12, PME–PME 1.12, PME–PLE 1.41, AME–PME 1.24, ALE–PLE 1.12. MOQ, aw: pw: 1 = 2.32: 2.76: 3.03. Width of clypeus to AME 0.59.

Labium: L 0.65, W 0.74. Sternum: L 2.14, W 1.78.

Legs: (Table 3) Anterior leg indices; 6.

Spination: As in *P. longbottomi* but 1 spine on anterior tibiae.

Palps: Embolus with $2\frac{1}{2}$ coils (Fig. 18); tibial apophysis narrow, dorsal ridge with curved point on apex (Fig. 19).

Female. CL 6.41, CW 5.38. AL 9.96, AW 4.89.

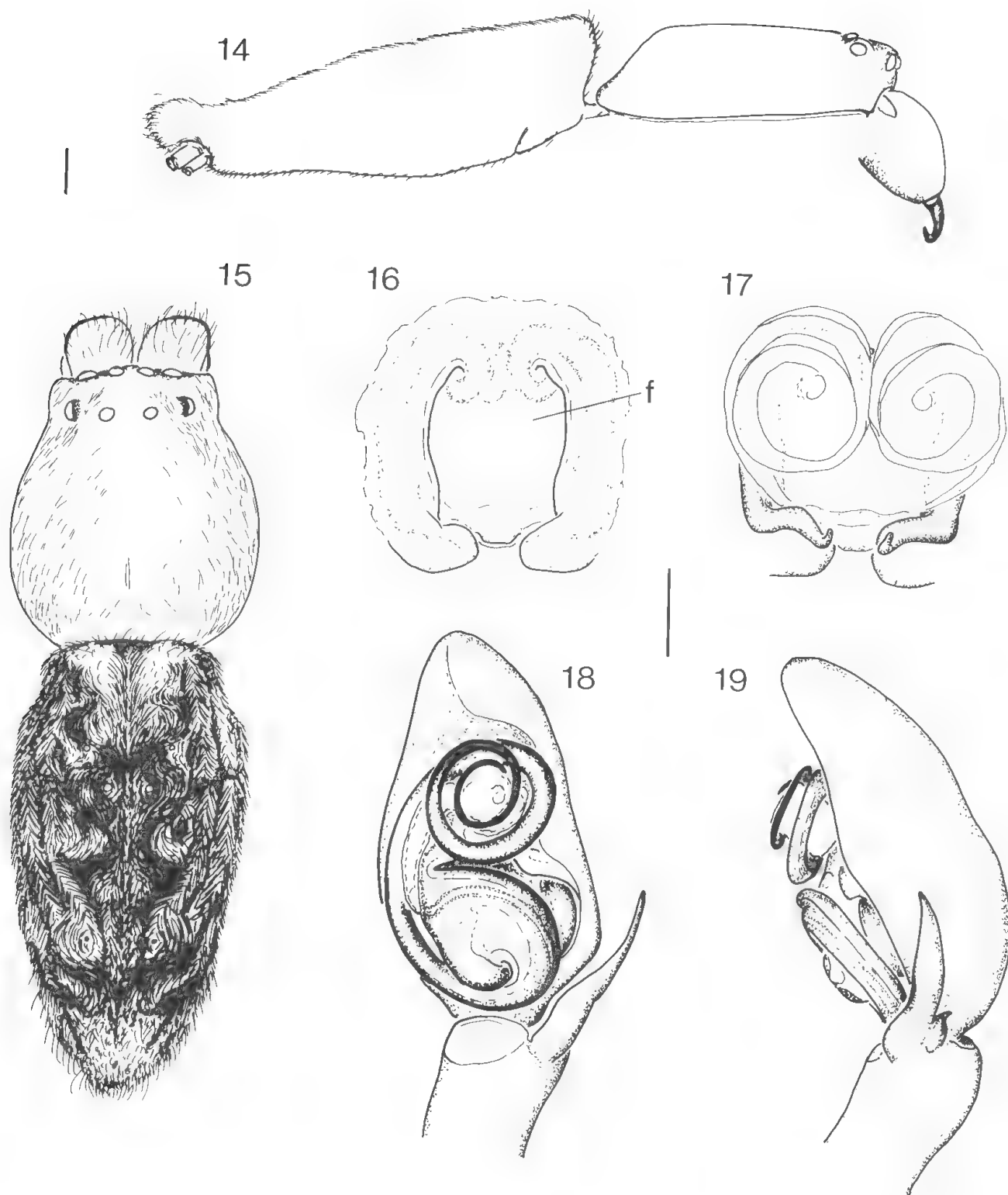
Colour in alcohol: As male but carapace with dense setae; white setae anterior to and posterior of AME. Chelicerae dark brown with short setae present on basal half. Maxillae and labium darker. Abdomen with dense short setae dorsally as on carapace but arranged in opposing directions to form a pattern (Fig. 15); venter with dull orange-brown badge with larger black patch posterior to epigastric furrow and more spots of black setae.

Eyes: AME 0.44. AME: ALE: PME: PLE = 1: 1.20: 0.91: 0.91. Interspaces; AME–AME 0.41, AME–ALE 0.18, PME–PME 1.18, PME–PLE 1.55, AME–PME 1.39, ALE–PLE 1.23. MOQ, aw: pw: 1 = 2.41: 3.00: 3.23. Width of clypeus to AME 0.73.

Labium: L 1.00, W 1.23. Sternum: L 2.94, W 2.38.

Legs: (Table 3) Anterior leg indices; 3.4.

Spination: As male but patellae III and IV lack a prolateral spine.



FIGURES 14–19. *Pediana temmei*, sp. nov. 14–15, female abdomen and carapace, 14, lateral, 15, dorsal; 16–17, female epigynum, 16, cleared, ventral, 17, vulva, dorsal; 18–19, male, left palp cymbium and tibia, 18, ventral; 19, retrolateral. Scale lines; Figs 14–15, 1mm, Figs 16–19, 0.5mm. f, fossa.

Epigynum: Fertilization ducts sharply bent posteriorly (Fig. 17). Vulva with small spermathecal sacs rising from fertilization duct

just under anterior margin of fossa and projecting anteriorly (Fig. 16), insemination ducts with $2\frac{1}{4}$ lightly sclerotised coils (Fig. 17).

TABLE 3. Leg measurements of *Pediana temmei*, sp. nov. Values are for holotype male with allotype female in parentheses

	Leg I	Leg 2	Leg 3	Leg 4	Palp
Femur	7.96 (6.78)	7.91 (6.79)	5.48 (4.74)	7.95 (6.89)	1.62 (2.15)
Patella	2.29 (2.69)	2.29 (2.72)	1.78 (2.13)	1.93 (2.22)	0.76 (1.11)
Tibia	6.73 (5.12)	6.71 (5.16)	4.19 (3.40)	6.16 (4.81)	0.88 (1.27)
Metatarsus	6.99 (5.28)	6.80 (5.11)	4.04 (3.29)	7.14 (5.35)	— —
Tarsus	2.01 (1.69)	2.02 (1.70)	1.43 (1.25)	1.82 (1.70)	1.83 (2.08)
Total	25.98 (21.56)	25.73 (21.48)	16.92 (14.81)	25.00 (20.97)	5.09 (6.61)

Variation

Carapace length of paratype males, 4.59 and 4.23; of paratype female 6.15.

Distribution

Known only from undulating sandplain country of the Great Victoria Desert in north-western South Australia (Fig. 26).

Remarks

Male *P. temmei* lack a posteriorly extended abdomen, while that of the female is only slightly extended (Fig. 14). *P. temmei* differs from all other *Pediana* species in lacking a 'typical' dorsal stripe. *P. temmei* is similar to *P. horni* in having a curved apical point on the dorsal ridge at the base of the male tibial apophysis but differs in embolic coiling as well as abdomen pattern.

Etymology

The specific epithet is used in recognition of the assistance and generosity given to the Arachnology Section by Dr Paul Temme, a member of the Waterhouse Club which supports the South Australian Museum.

Pediana paradoxa, sp. nov.

(Figs 20–26; Table 4)

Types

Holotype ♂, in *Hakea* nr rockhole, 18.5 km WNW Ungarinna Rockhole, (26°56'S 131°29'E), South Australia, 15.iii.1995, D. Hirst, SAMA N19956.

Allotype ♀, same data as holotype, SAMA N19957.

Diagnosis

Colour grey with black dorsal striping, venter lacks black patch anterior of spinnerets. Carapace highest posteriorly. ALE largest. Abdomen extended posteriorly beyond spinnerets. Male embolus with 2½ coils; dorsal ridge of tibial

apophysis with straight apex. Female spermathecal sacs small, projecting anteriorly from just outside anterior margin of fossa; insemination ducts with 2¾ lightly sclerotised coils.

Description

Male. CL 4.22, CW 3.78. AL 6.26, AW 2.70.

Colour in alcohol: Carapace brown, ocular area darker, numerous short black setae form a stripe medially, narrowly divided anteriorly by grey setae; laterals with adpressed grey-white setae. Chelicerae red-brown, long white setae. Maxillae and labium brown with dark brown suffusion. Sternum brown with darker suffusion, grey-white setae. Coxae and most parts of legs yellow-brown with blackish suffusion, legs III darker with numerous short black setae; anterior femora ventrally with white spots formed of short adpressed setae. Abdomen grey with numerous grey-white and golden setae. Black setae form a dorsal stripe broken medially and then wedge-shaped interspersed with golden setae; venter badge area yellow with black patch posterior to epigastric furrow, few grey spots medially, black suffusion anterior of spinnerets, patches of black and pale red suffusion lateral to badge area.

Eyes: AME 0.33. AME: ALE: PME: PLE = 1: 1.12: 0.85: 0.85. Interspaces; AME–AME 0.33, AME–ALE 0.09, PME–PME 1.27, PME–PLE 1.36, AME–PME 1.30, ALE–PLE 1.06. MOQ, aw: pw: l = 2.33: 2.97: 3.09. Width of clypeus to AME 0.67.

Labium: L 0.59, W 0.72. Sternum: L 2.14, W 1.78.

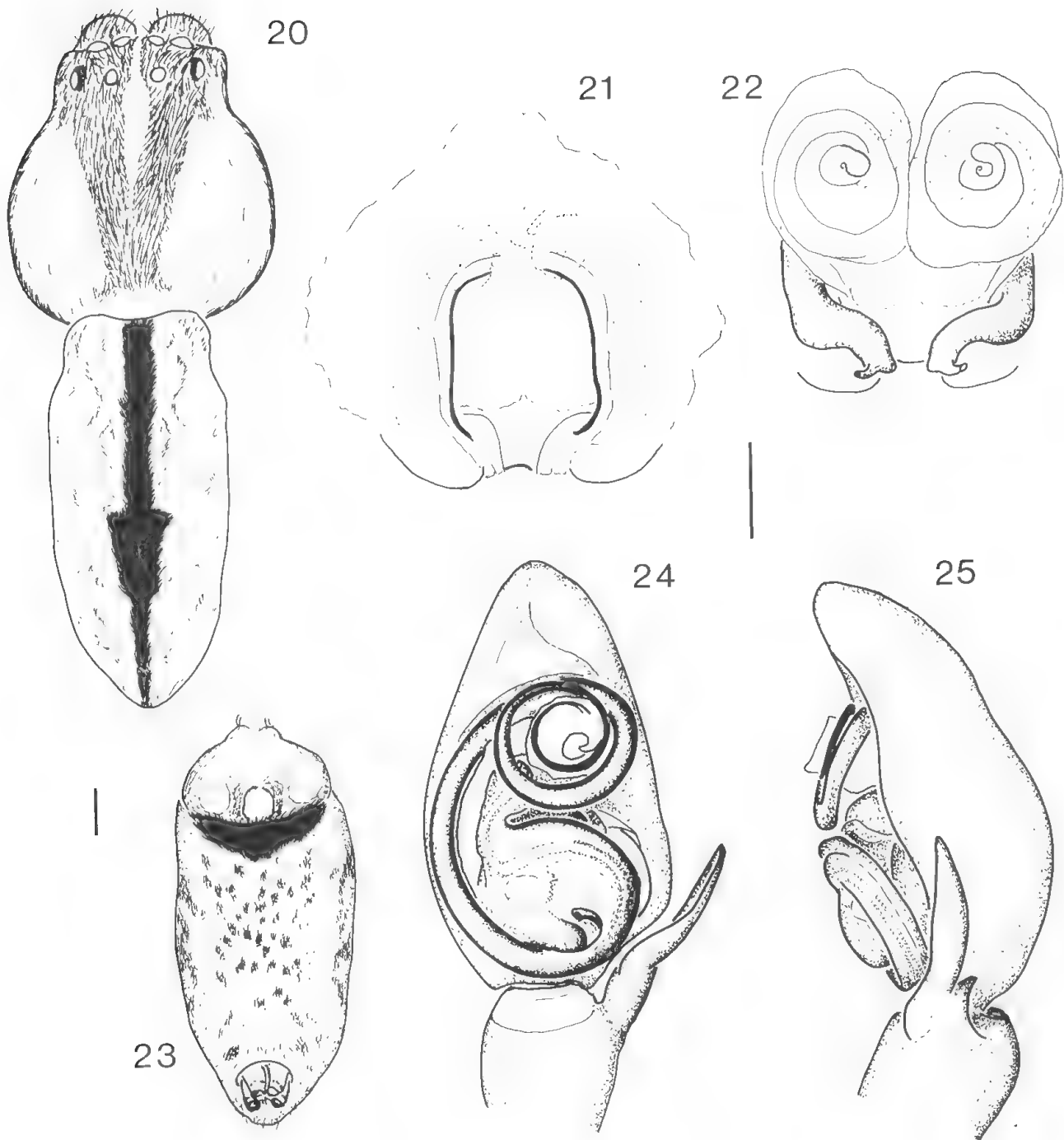
Legs: (Table 4) Anterior leg indices; 6.

Spination: As in *P. longbottomi* but patella IV lacks prolateral spine.

Palps: Embolus with 2½ coils (Fig. 24); tibial apophysis narrow, dorsal ridge with straight pointed apex (Fig. 25).

Female. CL 5.99, CW 5.28. AL 8.30, AW 3.75.

Colour in alcohol: As male but carapace with dense setae. Chelicerae with short orange setae on



FIGURES 20–25. *Pediana paradoxa*, sp. nov. 20, female abdomen and carapace, dorsal; 21, female abdomen, venter; 22–23, female epigynum, 22, cleared, ventral, 23, vulva, dorsal; 24–25, male, left palp cymbium and tibia, 24, ventral; 25, retrolateral. Scale lines; Figs 20–21, 1mm, Figs 22–25, 0.5mm.

basal half. Maxillae and labium brown with black suffusion. Abdomen (Fig. 20) with more numerous golden setae; venter with shiny black setae posterior to epigastric furrow; mixed white and red setae and spots of black setae (Fig. 21).

Eyes: AME 0.39. AME: ALE: PME: PLE = 1: 1.33: 0.92: 0.92. Interspaces; AME–AME 0.51,

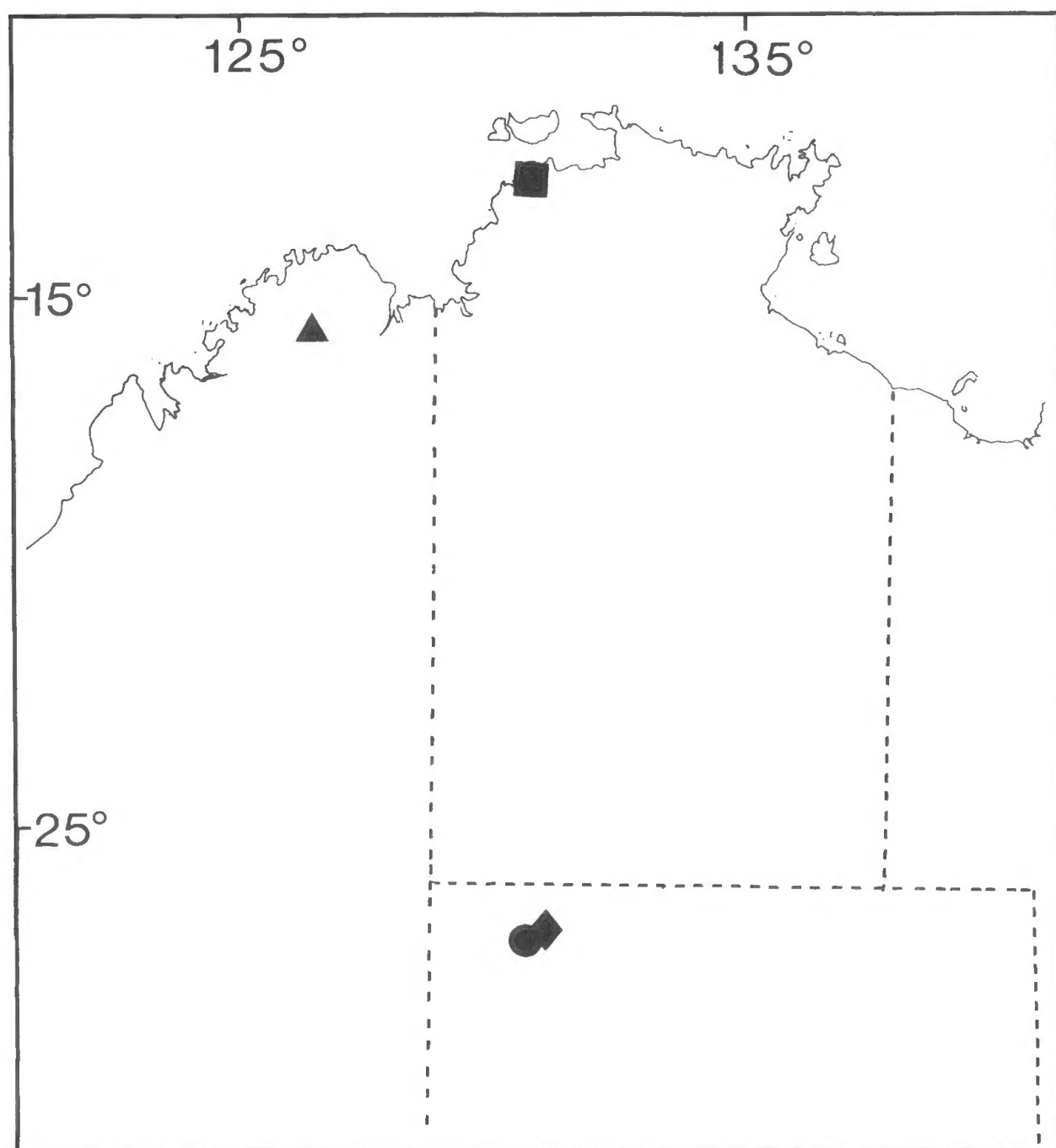
AME–ALE 0.02, PME–PME 1.31, PME–PLE 1.85, AME–PME 0.51, ALE–PLE 0.52. MOQ, aw: pw: l = 2.51: 3.15: 3.26. Width of clypeus to AME 0.77.

Labium: L 0.92, W 1.13. Sternum: L 2.82, W 2.23.

Legs: (Table 4) Anterior leg indices; 3.5.

TABLE 4. Leg measurements of *Pediana paradoxa*, sp. nov. Values are for holotype male with allotype female in parentheses

	Leg 1	Leg 2	Leg 3	Leg 4	Palp
Femur	7.71 (6.83)	7.72 (6.82)	5.17 (4.72)	7.86 (6.94)	1.68 (2.03)
Patella	2.23 (2.64)	2.21 (2.61)	1.74 (2.09)	1.79 (2.10)	0.66 (1.05)
Tibia	6.76 (5.29)	6.65 (5.25)	4.01 (3.48)	6.04 (4.91)	0.89 (1.24)
Metatarsus	6.74 (4.87)	6.62 (4.88)	3.79 (3.03)	6.97 (5.31)	— —
Tarsus	1.83 (1.53)	1.81 (1.55)	1.40 (1.38)	1.82 (1.52)	1.74 (1.95)
Total	25.27 (21.16)	25.01 (21.11)	16.11 (14.70)	24.48 (20.78)	4.97 (6.27)

FIGURE 26. Distribution of species of the *Pediana webberae* group: *P. webberae* ■; *P. longbottomi* ▲; *P. temmei* ●; *P. paradoxa* ◆.

Spination: As male but tibia II with 1 dorsal spine and patella IV with prolateral spine.

Epigynum: Similar to *P. temmei* but narrower; vulva with longer spermathecal sacs (Fig. 22), insemination ducts with $2\frac{3}{4}$ lightly sclerotised coils (Fig. 23).

Distribution

Known only from undulating sandplain country of the Great Victoria Desert in north-western South Australia (Fig. 26).

Remarks

P. paradoxa is most similar to *P. temmei* from which it differs in colour, in the male tibial apophysis having a straight-edged triangular shaped apex to the dorsal ridge, in the embolic base and female spermathecal sacs. Both *P. paradoxa* and *P. temmei* could be confused with *P. occidentalis* which has similar coiling of the male embolus and female insemination ducts, but *P. occidentalis* has an oval shaped abdomen, apical spinnerets, differences in the male embolic base and large posteriorly directed female spermathecal sacs.

Etymology

The specific epithet is taken from the Latin (paradox) and reflects both the puzzling similarity between this species and *P. temmei* and their 'side-by-side' distribution.

Pediana regina L. Koch

New Record

♀, W.A., King David River area, Drysdale River Stn (15°42'S 126°22'E), 15.viii.1993, A.F. Longbottom (S.1282), on tree, WAM 94/1695.

Apart from the longer spermathecal sacs of this female it cannot be separated from *P. regina*. All previous records are from eastern Australia, however Strand (1913) described a male and a penultimate female as a variety from Central Australia. Hirst (1989) placed those specimens in *P. horni* (Hogg) based on the description given by Strand. The specimens (in SMF) have since been seen and indeed belong to *P. horni*.

DISCUSSION

The female of *P. webberae* has a relatively high caput, as is usual for previously known species of the genus, but which differs markedly in having a steep declivity to a low cephalic portion (Fig. 1),

a modification of the cephalothorax unknown in an Australian heteropodid. However, the carapace of the male *P. webberae* has but a gradual declivity (Fig. 7) more comparable with that of its sister-species, *P. longbottomi* (Fig. 10). Forward projection of the spermathecal sacs in the female is not uncommon in the heteropodids as it occurs in *Zachria* L. Koch (Hirst 1991) and *Typostola* Simon (Hirst in prep.). However, in those species the spermathecal sacs originate from the fertilization ducts after the latter have curved into the fossa cavity and rise from the posterior side of the curve. The spermathecal sacs then arc to the anterior. While the spermathecal sacs of *P. temmei* and *P. paradoxa* rise from the fertilization ducts as they curve under the fossa (Figs 16, 22) nearer to the 'normal' position seen in most Australian Deleninae genera which possess spermathecal sacs, in *P. webberae* the spermathecal sacs originate before the fertilization ducts curve to enter the fossa cavity (Figs 5, 6). In all new species the abdomen is more elongate and extends posteriorly beyond the spinnerets (Fig. 3). Subapical spinnerets are also known in one species of *Delena* Walckenaer but which has an oval abdomen (pers. obs.). Subapical spinnerets have not previously been recorded in the Heteropodidae to my knowledge.

Further differences in *P. webberae* and *P. longbottomi* are not unique but noteworthy. Firstly, the setose posterior legs of the female *P. webberae* are distinctive (the poor condition of the only known male of this species excludes consideration here) having a brush-like appearance proventrally on the femur and tibia of leg IV and to some degree on the tibia of leg III. Although species of the *P. horni* group also have long setae on the ventral surface of leg IV (Hirst 1989) these setae are sparse. However long setae are more numerous on anterior legs of *P. tenuis* Hogg. Secondly, an elevation proximal to, and including the base of each leg spine, gives a tuberculate appearance (Fig. 4). This is most noticeable on the femora of *P. webberae* and can be seen in the male of *P. longbottomi* to a lesser degree. Lastly, the posterior eyes are smaller than in other species and, as the width of the posterior row is relatively the same, posterior eye interspaces are greater. Furthermore, the AME are largest in the male of *P. longbottomi*. Resolution of the AME size of the male *P. webberae* (see earlier) must await the availability of further material but certainly the AME of *P. webberae* are relatively larger than those of other known female *Pediana*.

Insemination ducts of the female and embolus of the male *P. webberae* have little more than one coil (Figs 6, 8) as in the embolus of the male *P. longbottomi*. Both are also similar in having the abdomen produced well beyond the level of the posterior spinnerets, in the carapace being low posteriorly (Fig. 10) and in the somewhat tuberculate legs. Males have a small embolic base and a relatively large subtegulum which, when viewed ventrally, is more exposed than in *P. temmei* and *P. paradoxa* and the *regina* group. However, carapace shape (Fig. 14) and coiling in the genitalia of the sister-species *P. temmei* and *P.*

paradoxa are most similar to the *regina* group but both are more easily grouped with *P. webberae* and *P. longbottomi* in having anteriorly directed spermathecal sacs, an elongate abdomen and subapical spinnerets.

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